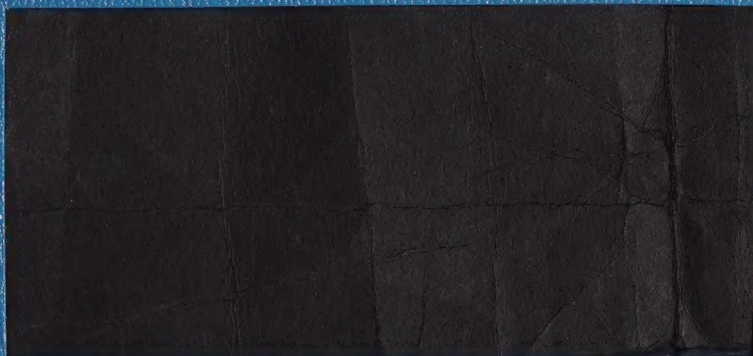


PLEASE
RETURN TO JOHN
TORRES

ITH

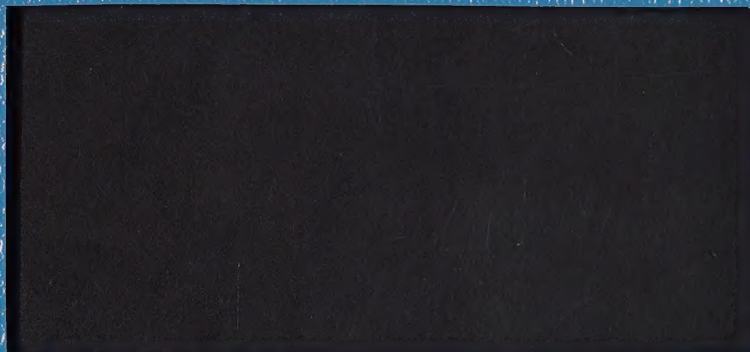


MP MASTER



MA34221

ITHACO



INSTRUCTION AND MAINTENANCE MANUAL

CURRENT AMPLIFIER

ITHACO MODEL 1211

JULY 1981

ITHACO, INC.
735 West Clinton Street
Box 818
Ithaca, New York 14850
Phone 607-272-7640

95548
TIM FREE
Technician

JIM Conley
customer Service

John Pease

Rep: by ITHIET
Sunnyvale CA.
(408) 249-2585

Ed Seymour (800) 847-2080

TABLE OF CONTENTS

<u>Section</u>	<u>Description</u>	<u>Page</u>
1	INTRODUCTION	
1.1	Description	1 - 1
1.2	Specifications	1 - 2
2	INSTALLATION	
2.1	Inspection	2 - 1
2.1.1	General	2 - 1
2.1.2	Visual Inspection	2 - 1
2.1.3	Electrical Inspection	2 - 1
2.2	Installation	2 - 1
2.3	Power and Grounding	2 - 1
3	OPERATING INSTRUCTIONS	
3.1	General	3 - 1
3.2	Inputs	3 - 1
3.2.1	Signal Input	3 - 1
3.2.2	Gate Input	3 - 1
3.3	Outputs	3 - 1
3.4	Controls	3 - 2
3.4.1	Sensitivity Switch	3 - 2
3.4.2	Multiplier Switch	3 - 2
3.4.3	Suppression Switch and Vernier	3 - 2
3.4.4	Rise Time Switch	3 - 2
3.4.5	Zero Set	3 - 2
3.4.6	Detector Bias	3 - 3
3.4.7	Power Switch	3 - 3
3.4.8	Battery Switch	3 - 3
3.5	Indicators	3 - 4
3.5.1	Overload	3 - 4
3.5.2	Battery Test	3 - 4
4	BATTERY OPERATION AND MAINTENANCE (OPTION 10)	
4.1	General Description	4 - 1
4.2	Rear Panel Battery Switch	4 - 1
4.3	Dual Rate Charging System	4 - 1
4.4	Battery Temperature	4 - 1
4.5	Changing the Battery	4 - 2
4.6	Converting the Charge Rate to C/10	4 - 2
4.7	Prolonging Battery Life	4 - 2

Digitized by the Internet Archive
in 2026

https://archive.org/details/manualsplus_11968

TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Description</u>	<u>Page</u>
5	CALIBRATION	5 - 1
5.1	Scope	5 - 1
5.2	Instrumentation	5 - 1
5.3	Test Setup	5 - 1
5.4	Procedure	5 - 2
5.4.1	Reference Voltages	5 - 2
5.4.2	Offset and Gains	5 - 2
5.4.3	Bias Compensation	5 - 4
5.4.4	Rise Time Adjust	5 - 5
5.4.5	Transformer Hum	5 - 8
5.5	Fault Isolation	5 - 9
6	REPLACEABLE PARTS	
6.1	Introduction	6 - 1
6.2	Reference Designations and Abbreviations	6 - 1
6.3	Replaceable Parts	6 - 1
6.3.1	Explanation of Location Column	6 - 1
6.4	Code List of Manufacturers	6 - 1
	Motherboard Assembly	6 - 3
	A5 Card	6 - 17
	Front Panel Assembly	6 - 18
	Rear Panel Assembly	6 - 19
	Power Supply	6 - 20
7	ASSEMBLY AND SCHEMATIC DRAWINGS	
7.1	Major Assembly	
7.2	Schematic - Input Gain	
7.3	Schematic - Sensitivity Switch and Buffer	
7.4	Schematic - Gate, LP Amp, Output	
7.5	Schematic - Ref Circuits	
7.6	Schematic - Power Supply/OVLD	
7.7	Assembly - A5 Card	
7.8	Assembly - Motherboard A3	
7.9	Assembly - Power Supply A4	
7.10	Assembly - Battery Pack Option 10	
RM1-RM2	Installation Instructions for ITHACO Rack Mounting Kit	
	Recommended Handling Procedures for MOS Devices	
	Warranty	
	FIGURES	
1.1	Block Diagram	
3.1	Simplified Schematic	
5.1	Waveform	

SECTION 1

INTRODUCTION

1.1 DESCRIPTION

The ITHACO Model 1211 Current Amplifier is a precision, high performance electronic instrument designed to push measurement capability in the 10^{-3} to 10^{-11} ampere range as close to the theoretical limit as permitted by current moderate price technology. The Model 1211 combines high speed, low noise performance with convenience features not found in competing amplifiers.

Sensitivity from 10^{-3} to 10^{-11} amperes per volt is selected in decade steps by a front panel rotary switch. A post conversion gain multiplier permits extension of the basic range and allows the operator to make noise/speed trade offs, or extend the dynamic range.

Suppression of either positive or negative current from 10^{-3} to 10^{-10} amperes is provided in calibrated decade steps. The center knob of the suppression switch is a continuous adjustment.

Rise time from .01 milliseconds to 1 second is selected in a 1-3-10 sequence by rotating the Rise Time switch. The attenuation rate may be set at -6 dB per octave or -12 dB per octave by a slide switch located inside the unit. The higher (-12 dB) attenuation rate is useful when cable capacitance increases the high frequency noise gain of the input amplifier gain block.

Other front panel controls and indicators include a zero set pot and switch, a battery test switch, power switch, and overload indicator. Located on the rear panel are the battery/line and charge rate switch, the detector bias pot, and the gate signal input BNC connector.

Input is via a front panel BNC connector. Several output BNC connectors are provided. The front panel output is 600 ohms, while both 600 ohm and 25 ohm outputs are available on the rear panel. Also available on the rear panel is the direct output (buffered) of the input gain block.

These functions and features will be explained in greater detail in Section 3.0, "Operating Instructions".

1.2 SPECIFICATIONS

See next page.

CURRENT AMPLIFIER

ITHACO

735 W. Clinton St. Box 6437 Ithaca, New York 14851-6437 Phone 607-272-7640 TWX 510-255-9307



FEATURES

- Gated Operation
 - Calibrated Rise Time $10\mu\text{sec}$ to 1 sec
 - Calibrated Current Suppression 10^{-3} to 10^{-10} amps
 - Detector Bias to 5 Volts (adjustable)
 - Battery/Line Operation
 - 600 ohm Output
 - 50 ohm Output (25mA)
 - Unity Gain (converter) Output

CAPABILITIES

- Range 10^{-2} to 10^{-11} Amperes
 - Rise Time to $10\mu\text{sec}$
 - Noise $< 10^{-13}$ Amperes
 - Offset Current $< 5 \times 10^{-13}$ Amperes
 - Dynamic Range to 96 dB
 - Output Stability Better than 0.003% (per °C or day)
 - Gain Accuracy Better than $\pm 3\%$
 - Gain Stability to 0.005% (per °C or day)

SPECIFICATIONS

RANGE	10 ⁻³ ampere per volt to 10 ⁻¹¹ ampere per volt, nine decade ranges (full output to 10 ⁻² ampere).			
OFFSET CURRENT	Less than 5 x 10 ⁻¹³ ampere.			
OUTPUT	±10 volts at up to 25mA			
RISE TIME	Adjustable, calibrated from 10μsec to 1 sec in 1-3-10 sequence.			
NOISE/RISE TIME	Gain (A/V)	Rise Time	*Dynamic Range	Noise Amperes (rms)
	10 ⁻¹¹	1.1mSec	48 dB (250)	1.5 x 10 ⁻¹³
	10 ⁻¹⁰	750μSec	55 dB (560)	6 x 10 ⁻¹³
	10 ⁻⁹	250μSec	62 dB (1260)	3 x 10 ⁻¹²
	10 ⁻⁸	40μSec	68 dB (2500)	1.5 x 10 ⁻¹¹
	10 ⁻⁷	25μSec	78 dB (7940)	4 x 10 ⁻¹¹
	10 ⁻⁶	15μSec	88 dB (25000)	1.5 x 10 ⁻¹⁰
	10 ⁻⁵	10μSec	96 dB (63000)	5 x 10 ⁻¹⁰
	10 ⁻⁴	10μSec	96 dB (63000)	5 x 10 ⁻⁹
	10 ⁻³	10μSec	96 dB (63000)	5 x 10 ⁻⁸
* Dynamic range with low pass filter at 10μSec (high speed).				
STABILITY	Output voltage stability better than 0.003%/°C and per 24-hours.			
CURRENT SUPPRESSION	10 ⁻³ ampere to 10 ⁻¹⁰ ampere in eight decade ranges plus 10-turn vernier.			
INPUT BIAS	Adjustable bias to ±5 volts, 100ppm/°C stability			
INPUT IMPEDANCE	Less than 5 ohm (10 ⁻³ to 10 ⁻⁵ ranges), increasing to less than 2 megohms (10 ⁻¹¹ range).			
INPUT VOLTAGE DROP	Less than 200 microvolts to 10 ⁻⁵ to 10 ⁻¹¹ ranges.			
GATING	Signal path may be gated via rear panel BNC-input, at up to 5 kHz rate. Closure to ground or TTL-compatible.			

1 800 8-472080

SPECIFICATIONS

GAIN: 10^{-3} to 10^{-11} ampere/volt with nine decade current gain ranges.

GAIN MULTIPLIER: Output gain multiplier varies sensitivity in 3 steps, X0.1, X1.0 and X10, for optimum dynamic range and overload capability.

GAIN ACCURACY: $\pm 2\%$ of reading (10^{-3} to 10^{-9} ampere/volt ranges); $\pm 3\%$ of reading 10^{-9} thru 10^{-11} ampere/volt ranges).

INPUT OFFSET CURRENT: Less than 10^{-12} ampere.

INPUT RESISTANCE: Less than 5Ω (10^{-3} to 10^{-5} ampere/volt ranges), increasing to less than $2 \times 10^6\Omega$ on the 10^{-11} ampere/volt range.

INPUT VOLTAGE DROP: Less than 200 microvolts, 10^{-5} to 10^{-11} ampere/volt ranges.

RISE TIME (Low Pass Filter): Front-Panel adjustable from 10 microseconds to 1 second in a 1-3-10 sequence; MIN position rise time is less than 5 microseconds.

NOISE/RISE TIME	Gain (A/V)	Rise Time	*Dynamic Range	Noise Amperes (rpm)
	10^{-11}	1.1mSec 2.8 kHz	48 dB (250)	1.5×10^{-13}
	10^{-10}	750μSec 4.2 kHz	55 dB (560)	6×10^{-13}
	10^{-9}	250μSec 2.5 kHz	62 dB (1260)	3×10^{-12}
	10^{-8}	40μSec 78 kHz	68 dB (2500)	1.5×10^{-11}
	10^{-7}	25μSec 125 kHz	78 dB (7940)	4×10^{-11}
	10^{-6}	15μSec 207 kHz	88 dB (25000)	1.5×10^{-10}
	10^{-5}	10μSec 313 kHz	96 dB (63000)	5×10^{-10}
	10^{-4}	10μSec 313 kHz	96 dB (63000)	5×10^{-9}
	10^{-3}	10μSec 313 kHz	96 dB (63000)	5×10^{-9}

*Dynamic Range with low pass filter at 10μSec (high speed).

NOTE: Noise and dynamic range given are with gain multiplier setting of X1.0. Dynamic range is ratio of maximum pk-pk output before overload to maximum pk-pk wideband output noise.

OUTPUT: Four outputs (BNC) as follows:

- 600Ω outputs (2)
- Lo-Z output (to 25mA, 50Ω)
- Unity gain output

OUTPUT STABILITY: Output voltage offset stability is better than 0.003% per °C.

CURRENT SUPPRESSIONS: 10^{-3} ampere to 10^{-10} ampere with eight decade ranges: front-panel vernier (10-turn) allows continuous suppression with 0.1% resolution. Stability is better than .02%/°C or day (10^{-3} to 10^{-8} ampere); better than 0.2%/°C or day (10^{-9} and 10^{-10} ampere).

DETECTOR BIAS: Zero to ± 5 volts, adjustable and polarity-selectable with rear-panel vernier (10-turn) and switch. Stability is 100ppm/°C.

GATING: TTL-compatible logic 0 (rear-panel BNC input) provides gated operation of preamplifier signal path; maximum gating frequency is 5 kHz.

POWER: 100 to 130 or 200 to 260 VAC (switch-selectable), 50-60 Hz, 6 Watts.

DIMENSIONS: 3.5" high x 8.5" wide x 15" deep.

WEIGHT: 8 lbs.

OPERATING TEMPERATURE: 5°C to 50°C.

1211 BLOCK DIAGRAM

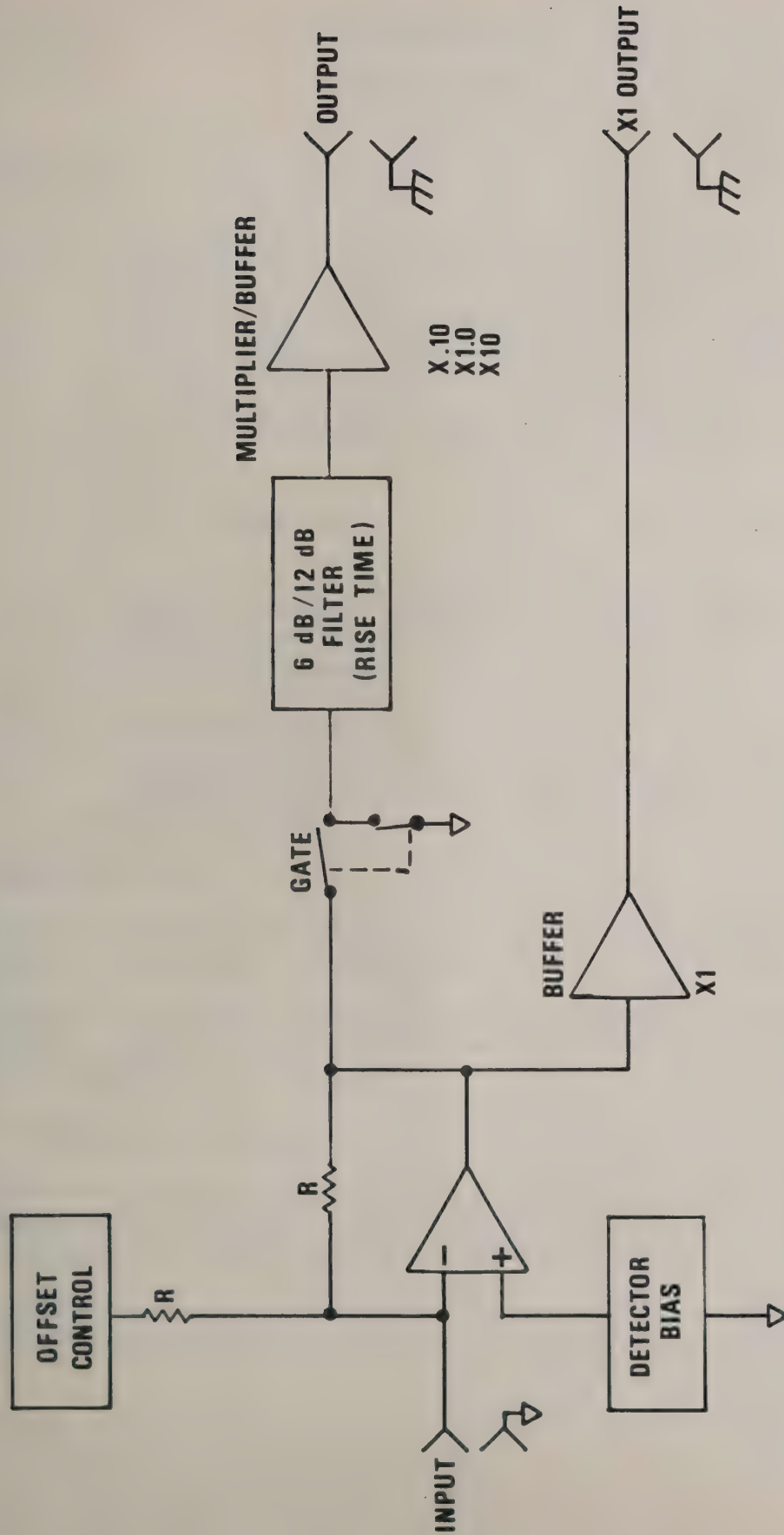


FIGURE 1.1

SECTION 2

INSTALLATION

2.1 INSPECTION

2.1.1 Before shipment, the Model 1211 was found to be free of electrical and mechanical defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing material until the inspection is complete. If damaged in any way, a claim should be filed with the carrier and a copy forwarded to ITHACO. ITHACO will then advise you as to the disposition of the equipment and will arrange for repair or replacement of the equipment without waiting for a settlement of a claim against the carrier.

2.1.2 VISUAL INSPECTION

A visual check should be made to confirm that there are no broken knobs or connectors, that the case and panel surfaces are free of dents and scratches and that the frame, transformer, and battery pack are undamaged.

2.1.3 ELECTRICAL INSPECTION

The instrument should be checked against its electrical specifications (see Section 1).

2.2 INSTALLATION

The 1211 Current Amplifier needs only to be connected to a power source for normal bench top use. See Section 2.3, "Power and Grounding".

For those installations where rack mounting is desired, two rack mounting kits are available: Model RM-1 for two 1211's side by side; Model RM-2 for a single 1211 in a 19" rack.

2.3 POWER AND GROUNDING

Unless otherwise specified, all units are shipped with a six foot, three conductor power cord equipped with a grounded plug. Normally, the 1211 should be connected to a grounded power source.

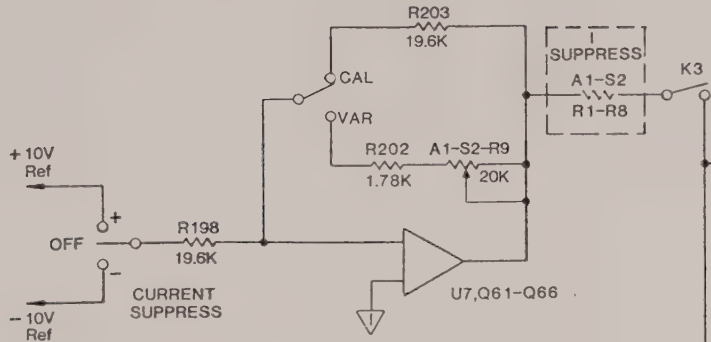
Before connecting the 1211 to the line, check that the line voltage switch (inside rear panel connector) is in the proper position.

<u>50-400 Hz Setting</u>	<u>Voltage Range</u>	<u>Recommended Slo-Blow Fuse</u>
100	90-110 VAC	0.25A
120	105-130 VAC	0.25A
220	195-240 VAC	0.125A
240	210-260 VAC	0.125A

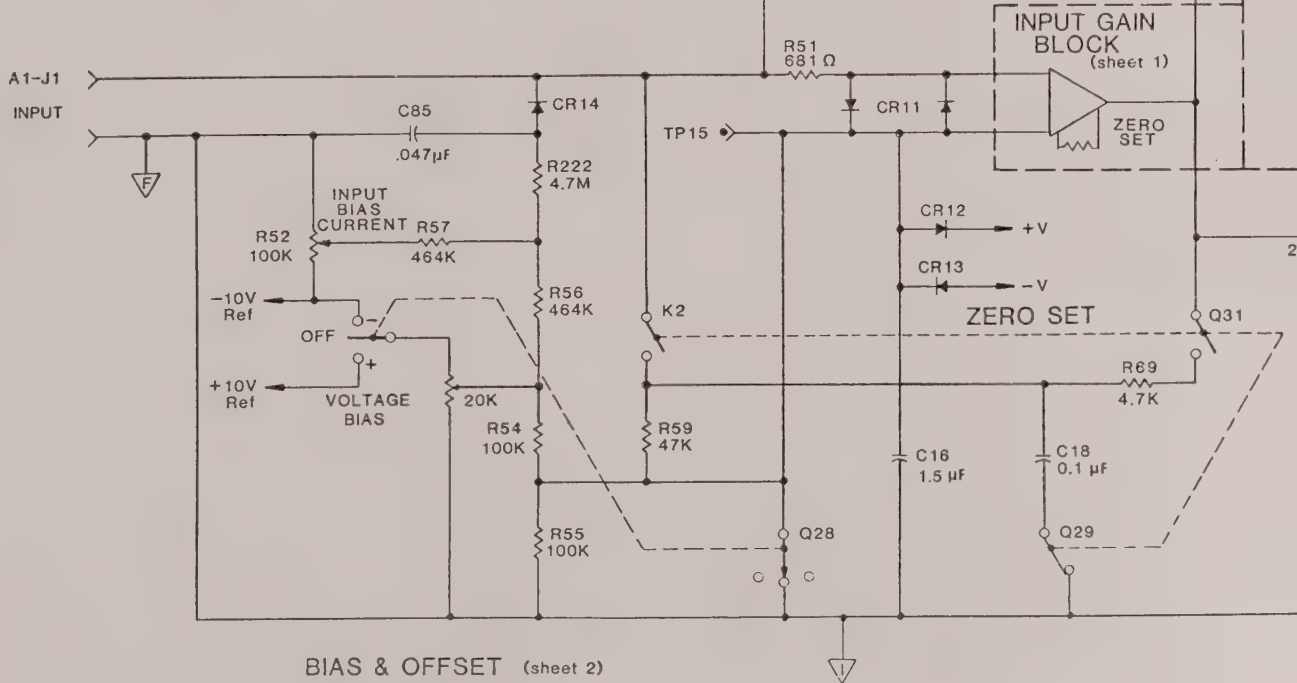
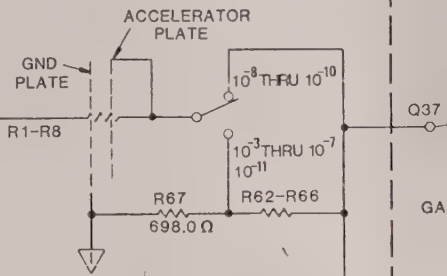
To change the power setting, first turn off the unit. Remove the power cord and slide the plastic window to one side. Remove the fuse by pulling out on the "fuse pull" lever. Remove the small printed circuit board by hooking a stiff wire in the hole at the rear of the board and pulling straight out. Select the proper voltage setting from the above table and orient the board so the desired setting will be visible through the window when the board is reinserted. Reinsert the board in the desired orientation, install the proper fuse and push the "fuse pull" lever back. Slide the window back and reconnect the power cord.

For Battery Operation (Option 10), see Section 4 "Battery Operation and Maintenance".

I SUPPRESS (sheet 4)



A1-S1 SENSITIVITY SWITCH (sheet 2)



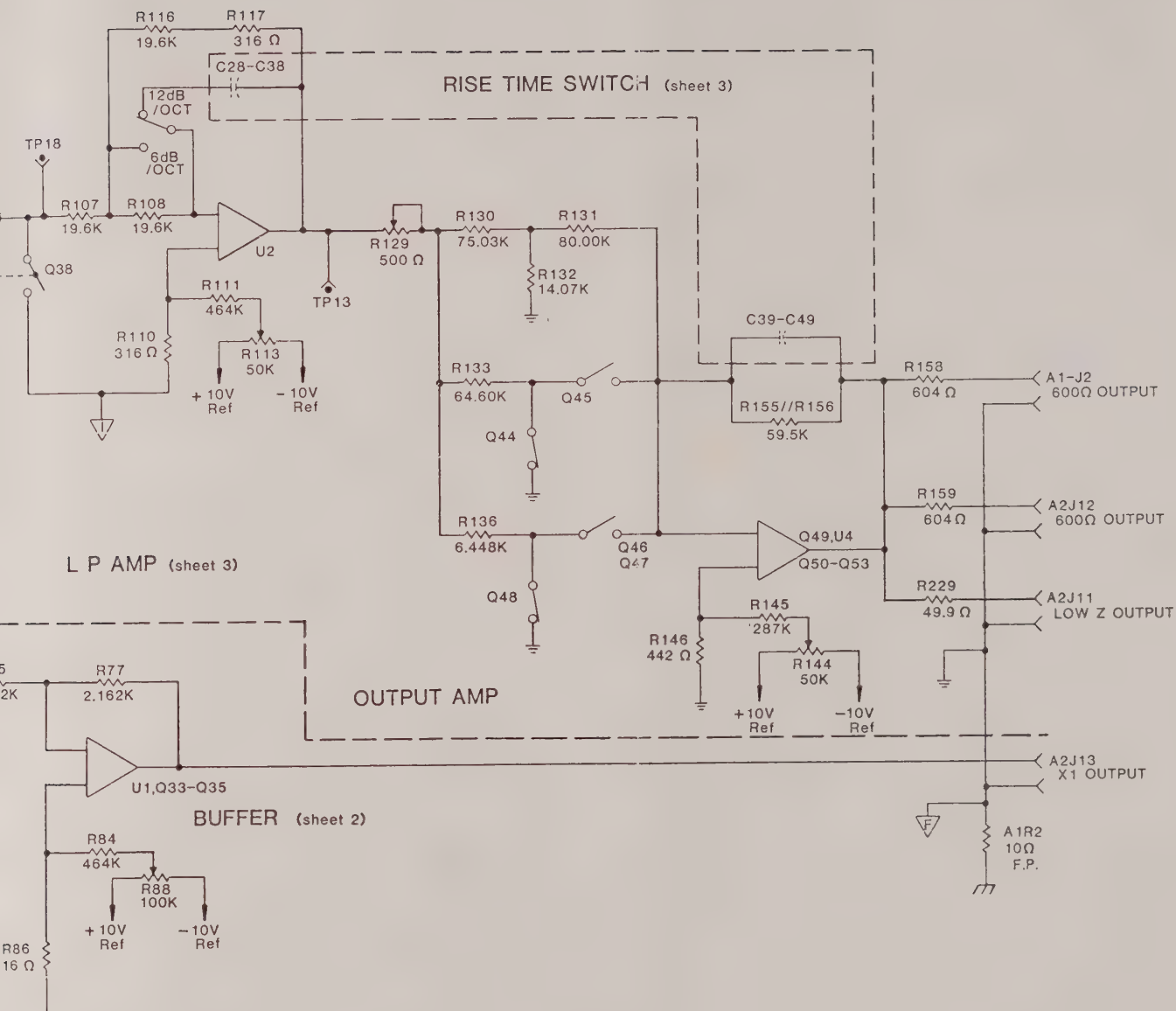


FIGURE 3.1
SIMPLIFIED SCHEMATIC
MODEL 1211

OPERATING INSTRUCTIONS

3.1 GENERAL

Before using the Model 1211 for the first time, or moving the instrument to a new location where AC power may be different, check the window on the fuse holder (rear panel) to be certain that the instrument matches the available AC power. If it is necessary to change the AC line voltage setting of the 1211, refer to Section 2.3.

The functions of all controls and indicators are for the most part, self explanatory. The following descriptions define these functions and show where possible how they interact to determine the overall performance of the instrument.

3.2 INPUTS

3.2.1 SIGNAL INPUT

Signal input to the Model 1211 is via a front panel BNC connector. In order to minimize peaking and high frequency noise, cable capacitance and other sources of shunt capacitance should be minimized. The high loop gain of the 1211 assures that the input port is at virtual ground under all normal operating conditions.

3.2.2 GATE INPUT

When the gate BNC on the rear panel is left open, the gating circuit is inactive and signals pass normally from input to output. When the gate input is grounded (0V up to approximately 0.8V), the gating circuit is activated and interrupts the signal path, preventing an active output.

The gating feature is especially useful when strong overloading signals are present at the amplifier input at a predetermined time. For example: in fluorescence decay studies or DLTS experiments, it is often desirable to prevent strong excitation signals from overloading electronic signal conditioners or read out devices. This is readily accomplished using the gating feature of the Model 1211.

3.3 OUTPUTS

Three of the output ports, all BNC, are driven from a common amplifier. The front panel has a single 600 ohm port. The rear panel has a 600 ohm port and a 50 ohm port capable of driving up to 25mA. Source resistors for all three ports are independent.

The output of the current to voltage converter is buffered and appears on a rear panel BNC connector. This low source impedance output is not gated, thereby allowing the user to observe signals "masked" by the gate.

3.4 CONTROLS

3.4.1 SENSITIVITY SWITCH

The Sensitivity switch provides for selection of sensitivity in decade increments from 10^{-3} to 10^{-11} amperes per volt. This switch selects the feedback resistor used in the input gain block, and therefore determines the noise and speed performance of the amplifier.

3.4.2 MULTIPLIER SWITCH

This switch controls the gain of the output stage in decade steps from 10^{-1} to 10. Because noise and speed performance are determined by the sensitivity switch, the multiplier may be used to increase speed at the expense of noise performance. See Noise/Rise Time specification (Section 1.2). The Multiplier switch may also be used in conjunction with the Rise Time switch to increase the dynamic reserve (i.e. ability to handle noise).

3.4.3 SUPPRESSION SWITCH AND VERNIER

The Model 1211 is equipped with a calibrated Current Suppression switch. Covering the range from 10^{-3} to 10^{-10} amperes in decade steps, the suppression circuit supplies a positive or negative current to the summing junction of the input gain block. Polarity is determined by the position of the center off toggle switch located immediately below the Suppression switch. In addition, a 10 turn vernier is provided on the center knob of the Suppression switch. A "Cal/Var" switch, located to the right of the Polarity switch, permits the vernier to be switched in and out without disturbing the vernier setting.

3.4.4 RISE TIME SWITCH

The function of this switch is to set the low pass filter for optimum noise performance. It is calibrated in milliseconds and covers a range from 10^{-5} seconds to 1 second in a 1, 3, 10 sequence. The filter is disabled when the switch is in the "min" position. For most applications the filter should be used in the 12 dB/octave mode. However, if the 1211 is to be used in a closed loop, it is necessary to switch to the 6 dB/octave mode in order to maintain a stable loop. The 6 dB/12 dB Mode switch is located on the PC board. It is therefore necessary to remove the top cover in order to change filter mode. Front panel Rise Time calibration is valid only for the 12 dB/octave position.

3.4.5 ZERO SET

The Zero Set switch places the input gain block in a gain of 10 configuration to permit voltage balance of the instrument. The screw-driver adjustable zero pot is located immediately above the Zero Set Switch. In order to properly zero the instrument, the input must be

open, the Current Suppression off, and the Detector Bias (Section 3.4.6) off.

For convenience of operation, the Zero Set toggle switch locks in the up position, and is momentary contact in the down position. The center position is off.

3.4.6 DETECTOR BIAS

Located on the rear panel, the Detector Bias pot (recessed screw-driver adjust) provides up to ± 5 volt offset of the 1211 input summing junction. Polarity is selected by a center off toggle switch located immediately to the left of the Bias Pot.

To set the Detector Bias, set the Sensitivity switch to the 10^{-8} amperes per volt scale, Multiplier to X1, Current Suppression off, and Zero Set on. The input should not be connected. While monitoring the output with a suitable readout device (e.g. DVM), adjust the Bias pot for the desired level. Once adjusted, the bias setting is valid for all sensitivity ranges. It is important, however, that the 10^{-8} , 10^{-9} or 10^{-10} range is used in the set procedure.

3.4.7 POWER SWITCH

This switch applies power to the 1211 signal processing circuits. The Battery pack (Option 10) charges even when the Power switch is off as long as the line cord is connected to AC power.

3.4.8 BATTERY SWITCH (BATT, C/25, C/10) (applies only if Option 10 is installed)

C/25 The amplifier will probably be received from the factory with the switch in this position. With the line cord plugged in, the internal batteries trickle-charge. The 1211 electronics operate from the internal power supply.

C/10 The batteries charge at the fast rate in this position. This instrument is provided with cooling holes but the user should not charge the batteries at C/10 (fast rate) for long periods at an unusually high ambient temperature or if the case has no air circulation. The build up of heat inside the case may shorten battery life. (See Section 4)

In both C/25 and C/10 positions the batteries charge at the selected rate provided the line cord is connected to a power source. The amplifier receives power from the internal power supply.

BATT In this switch position the batteries charge at the C/25 (slow) rate provided the line cord is connected to a power

source. The amplifier receives power from the batteries, whether or not the line is plugged in.

To prevent excessive battery drain when operating in the battery mode, do not operate for long periods of time with the overload light turned on. Also, try to avoid high load currents on the outputs, as this will reduce battery life.

3.5 INDICATORS

3.5.1 OVERLOAD

The output circuits of the input gain block and the output amplifier are monitored for overload. If an overload occurs in either circuit, the front panel overload lamp is illuminated. When correcting an overload condition, it is necessary to keep the gain distribution and filter setting in mind (see Figure 1.1). Recall from Section 3.4.2 that noise and/or speed performance can be traded for dynamic reserve.

3.5.2 BATTERY TEST (Applies only if Option 10 is installed)

The Battery Test light illuminates when the BATT test switch is operated and the battery voltages are at 11.2 volts or more.

In the + position, the light indicates positive amplifier battery condition and in the - position the light indicates negative amplifier battery condition.

The battery test light does not indicate the amount of battery charge, but only whether there is a voltage over 11.2 volts. Therefore, the lamp will light even though the batteries are approaching the end of their useful charge life. To insure adequate battery charge after receipt from the factory, charge overnight before using at the C/10 rate. The batteries will charge at the selected rate even with the power switch off as long as the line cord is connected to a power source. See Section 4.

BATTERY OPERATION AND MAINTENANCE
(OPTION 10 ONLY)

4.1 GENERAL DESCRIPTION

Your ITHACO 1211 Current Amplifier with Option 10 is equipped with two rechargeable nickel-cadmium 1.2A-hr battery packs. When fully charged, they can be expected to operate the 1211 under normal operating conditions for time periods of well over 25 hours. However, to maintain your battery's capability for several years requires care and attention on your part.

4.2 REAR PANEL BATTERY SWITCH

The rear panel switch provides a charge rate control as well as a choice of power supply mode. In the C/10 and C/25 positions, the preamplifier operates from the internal power supply. In the battery position, the preamplifier draws power from the batteries. If the preamplifier is plugged into a live power outlet, the battery receives charging current no matter what position the rear panel switch is in. NOTE THAT THE CHARGE RATE, IN THE BATTERY POSITION, IS C/25.

4.3 DUAL RATE CHARGING SYSTEM

The dual rate charging system is designed to prolong the battery life. Either the C/10 or C/25 charge rate may be selected via the rear panel. The term C is the ampere-hour rating of the battery. Thus if $C = 1.2\text{A-hr}$, then C/10 implies a maximum charge current of 120mA. At C/10 the battery should full charge in 14-15 hours (charge efficiency is less than 100%). However, nickel-cadmium batteries should not be charged at the C/10 rate over long periods of time.

It is expected that a number of users will not use the battery on a routine continuous basis, but will only call upon the battery occasionally. In that case, it is not necessary to maintain the battery charge rate at the C/10 limit. The C/25 position is recommended for the standby applications. The C/25 rate is high enough to charge a deep discharged battery after several days. It is high enough to amply supply the normal internal discharge current of the battery, but low enough so that it will not stress the overcharge mechanism of the battery. In addition, battery temperature rise will be reduced.

4.4 BATTERY TEMPERATURE

Another lifetime battery consideration is temperature. The 1211 is vented for cooling. The unit is designed for sufficient cooling for use, at room temperature on an open bench, at any charge rate. If the unit is installed in a closed rack where temperatures are high and air flow is restricted, it is recommended that the battery be removed for maximum life. If the battery is required, it is recommended that the charge rate be limited to C/25.

4.5 CHARGING THE BATTERY

When you receive your 1211 from the factory, the charge rate in the BATT position will be C/25. It is recommended that you use the rear panel selector switch to control the charge current. At the end of a day of using battery power, plug the 1211 into an outlet and switch to C/10 for a full overnight recharge.

4.6 CONVERTING THE CHARGE RATE TO C/10

If it is inconvenient or annoying to use the rear panel switch to control the charge rate and you would prefer the C/10 charge rate in the BATT position, you may easily convert the 1211. Simply add four wires to the rear panel selector switch. Wire pin 5 to pin 9, pin 7 to pin 11, pin 1 to pin 13 and pin 3 to pin 15 right on the switch. This will convert the charge rate in the battery position from C/25 to C/10.

4.7 PROLONGING BATTERY LIFE

The following rules for prolonging battery life should be followed:

1. Upon receipt of the instrument from the factory, charge overnight at C/10.
2. Select C/25 for standby battery charge maintenance.
3. Avoid temperature extremes and cycles as much as possible.
4. For rack mounted use, remove the battery. If battery is required, limit the charge rate to C/25 as much as possible. The consideration here is one of high temperatures.
5. If the battery (in or out of the 1211) is in storage, perform an overnight recharge at C/10 at approximately 3 month intervals.
6. Avoid repeated charge/discharge cycles of the same duration. Nickel-cadmium cells display a memory effect which means that they will eventually provide only the capacity asked from them on a routine basis. If your cells do appear to have a degraded capacity, they need replacing. Try an overnight C/10 recharge to erase any memory effect. If the batteries still appear weak, as a last resort, unplug the 1211 and leave it "on" in battery mode for several days to completely discharge the packs. Then recharge overnight at C/10. Sometimes battery capacity can be restored by cycling the pack in this manner. NOTE: Do not attempt to rush this process by discharging at high currents as cell reversal phenomenon will be aggravated leading to more permanent cell damage.
7. Recharge the battery after use even though the battery test light comes on. Nickel-cadmium batteries maintain a constant output voltage until they are almost completely discharged. The battery test light indicates that the battery has sufficient voltage to operate the 1211 not that it has ample reserves of energy.

SECTION 5

CALIBRATION

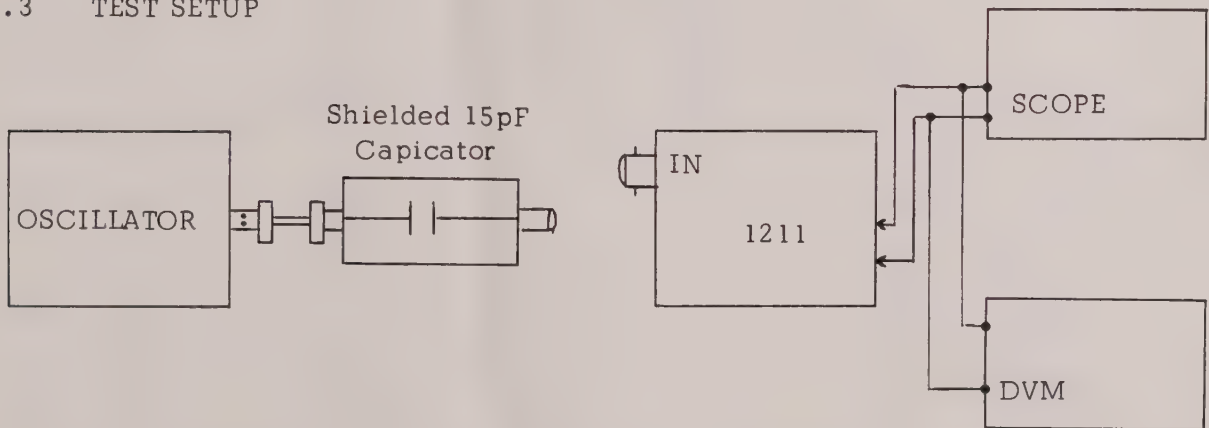
5.1 SCOPE

The purpose of this procedure is to align the 1211 prior to specifications check. Fault isolation to the functional block level is also provided.

5.2 INSTRUMENTATION

- a. Oscilloscope
- b. DVM - 100 μ V Resolution, true rms
- c. Audio Oscillator, sine and triangle wave output, 50 ohm
- d. Shorting cap, BNC
- e. Non-shorting cap, BNC
- f. 10" jumper wire - .025" square ends
- g. Low noise 40 dB amplifier
- h. Step Attenuator, 50 ohms
- i. Shielded 15pF capacitor
- j. 56 ohm resistor

5.3 TEST SETUP



Note: It is recommended to look at all points with both scope and DVM during alignment.

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS			COMMENTS
				MIN	TYP	MAX	
5.4 PROCEDURE	WARNING: THIS UNIT CONTAINS HIGH IMPEDANCE CIRCUITRY.						
NOTE: R13 (A3) and R5, R22 (A4) are adjusted during Sub-Assy. board tests. No realignment should be necessary.							
5.4.1 REFERENCE VOLTAGES	I. Supp. : Neg : CAL	N/A	2. DVM: PIN 36 3. Adjust R185	-10.010	-10.000	-9.090	D.C.V
-10V REF	I. Supp. • POS • CAL		2. Deviation from -10V . 3. Readjust R185 to evenly distribute ±Ref Voltage around 10volts	0	±.150	±.250	D.C.V. ±10V Ref is the calibrated supply the I suppress and should be adjusted only for that purp
5.4.2 OFFSETS AND GAINS							
X1 OFFSET		1. disconnect pins 85,86 (P21) 2. Short Pin 86 to pin 97 (GRD). 5. Reconnect pins 85,86 (P21)	3. DVM : J13(X1 out) 4. Adjust R88	-.2	0	+ .2	D.C.V.

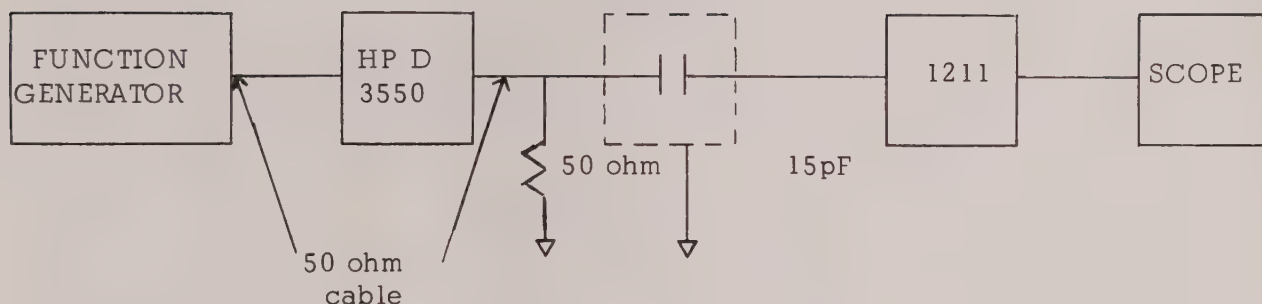
TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS			COMMENTS
				MIN	TYP	MAX	
2nd L.P. OFFSET	1. Rise Time: 10(ms) 2. Sens. Mult.: X.1	3. Gate input: Install shorting cap 4. Disconnect pins 94,95 (P22) 5. Connect a 56 ohm resistor between TP19 and TP20. 8. Remove 56Ω resistor between TP19 and TP20. 9. Reconnect Pins 94,95 (P22).	6. DVM: 600Ω out 7. Adjust R144	-100mv	0	+100mV	D.C.V.
1st. L.P. OFFSET		3. Remove gate input shorting cap.	1. DVM: 600Ω out 2. Adjust R113	-3mV	0	+3mv	D.C.V.
INPUT AMP OFFSET	1. Sens. :10 ⁻³ A/V 2. Sens. mult.: X0.1 3. V.BIAS: OFF 4. I.Supp.: OFF 5. Zero Set: OFF		6. DVM: 600Ω out 7. Adjust A1-R1 throughout range 8. Adjust A1-R1	±600mv		±700mv	
				-10mv	0	+10mv	

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN TYP MAX	COMMENTS
GAIN ADJUST	1. Sens. Mult.: X1	2. Disconnect Pins 83, 84 (P20)	4. DVM: TP11	-10.110 -10.000 -9.890	Remember Reading
		3. Connect Pin 84 to TP11 (-10V)	5. DVM: Lo-Z out		Adjust for same reading as at TP11.
			6. Adjust R129	±1mv	
5.4.3 BIAS COMPENSATION	1. I. Supp.: OFF		7. Reconnect pins 83, 84 (P20)		Remember DC Reading
	2. V. BIAS: OFF				
	3. SENS: 10^{-3} A/V				*0±0.2VDC change from 7
	4. Sens. Mult.: X.1				(10^{-3} A/V setting)
	5. A3-S1: 12dB				
	6. Rise time: 300(ms)				
	8. Sens: 10^{-11} A/V		7. DVM: Lo-Z out	±.2V*	
			9. Adjust R52 for same reading as 7 above		

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST MIN	LIMITS TYP	MAX	COMMENTS
5.4.4 RISE TIME ADJUST	1. A3-S1: 6dB 2. V.BIAS: OFF 3. Rise Time: .01(ms) 4. Sens. Mult.: X1 5. I.Supp.: OFF	6. Disconnect Pins 83, 84 (P20) 7. Connect 60.0KHz ≈ 1VRMS, sine wave to pin 84.	8. DVM - TP13 (A.C.V.) 9. Adjust oscillator amplitude for 1.000VRMS 10. DVM: Lo-Z out (ACV) 11. Adjust C64.	650mv	655mv	660mv	RMS
2nd L.P. RISE TIME	1. A3-S1: 12 dB 2. V.Bias: OFF 3. Rise Time: .01(ms) 4. Sens. Mult: X1 5. I.Supp.: OFF	6. Connect 60.0kHz, ≈ 1VRMS, sine wave to pin 84.	7. Adjust oscillator amplitude for 1.00VRMS 8. DVM: TP 13 9. Adjust C56.	670mv	675mv	680mv	RMS
1st L.P. RISE TIME							

INPUT RISE TIME

SETUP



- a. Feed a 3V P-P triangle wave into HP attenuator. Make sure the triangle wave has no spikes at the top and bottom.
- b. Connect the attenuator output to the 1211 through a shielded 15pF capacitor. Connections must be as short as possible. Do not use coax.

SENSITIVITY	$10^{-8} \times 1$	$10^{-9} \times 1$	$10^{-10} \times 1$	$10^{-11} \times 1$
1) Adjust frequency and attenuator for 2.5V p-p output from 1211.	$\approx 1.6\text{kHz}$ @20 dB	$\approx 160\text{Hz}$ @20 dB	$\approx 16\text{Hz}$ @20dB	$\approx 16\text{Hz}$ @40 dB
2) Adjust pots on side rail mounted board for critically damped square wave with fastest rise time possible. See Figure 5.1		R2 then R1 repeat as often as necessary	R5 then R4 repeat as often as necessary	R8 then R7 repeat as often as necessary
3) Rise time nominal	24 μs	80 μs	580 μs	750 μs
4) Rise time spec	40 μs	250 μs	750 μs	1.1ms

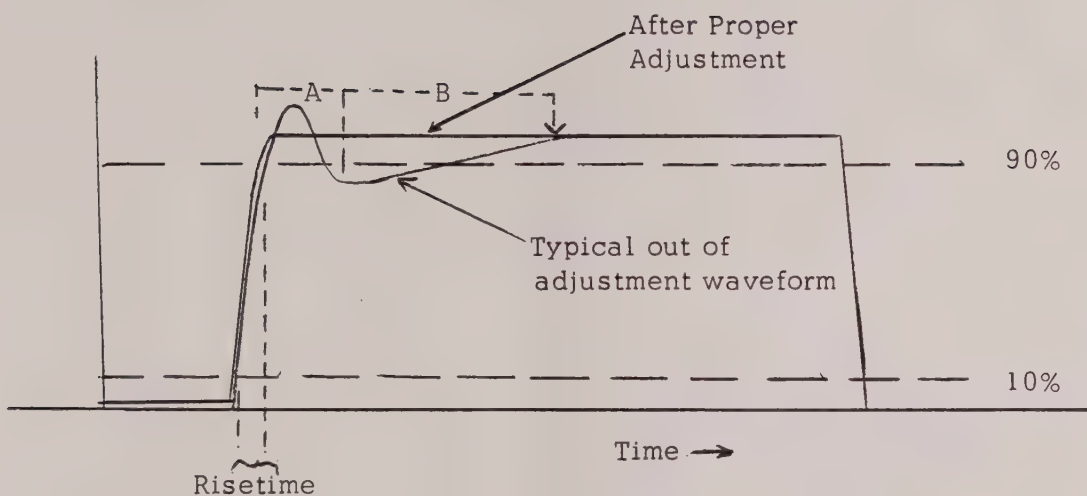
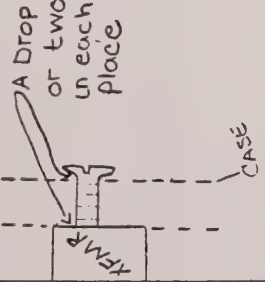


FIGURE 5.1

WAVEFORM

The area around section A is controlled by R2, R5, R8.
 The area around section B is controlled by R1, R4, R7.

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN TYP MAX	COMMENTS
5.4.4.5 TRANSFORMER HUM	1. SENS: 10^{-6} A/V 2. Sens. Mult: X1 3. Risettime: 10 (mSec) 4. I. Supp: OFF 5. A3-S1: 12dB 6. V. BIAS: OFF	7. NON-SHORTING CAP ON INPUT (I1)	8. Connect scope to I0-Z out through a X100 AMP 9. Rotate XFMR for minimum hum at line related frequencies 10. Apply Loctite SPARINGLY to threads and head of XFMR screw and tighten. 		

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TESTS	ACTION
5.5 FAULT ISOLATION	-10V REF	1. Check TP12 for +10VDC capability when R185 is adjusted. 2. Check PIN 37 for +10VDC capability when R185 is adjusted	1. If not, check A1-57 and wiring. -----
	±10V DISTRIBUTION	1. Check PIN 37 for 220mV deviation between $ + $ and $ - $ I supresses (switch positions). 2. Check TP11 and TP12 for <220mV deviation between $ + $ and $ - $ voltages.	1. If OK, check A1-S7 and wiring for shorts (normal and high impedance), opens or misswiring. -----
	X1 OFFSET	1. Check voltage swing across RB6 for ±6.6mV.	1. If not, check ±10V reference (TP11,TP12) -----
	1st L.P. AMP	1. Disconnect Pins 83,84 (P20) and ground Pin 84 to Pin 97, reattempt alignment. 2. Remove BNC cap on gate and reattempt alignment.	-----

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TESTS	ACTION
5.5 Cont'd	Input AMP offset (insufficient swing)	1. Check A1-R1 wiring. 2. Check voltage across R21 for 1.12V to 1.31 VDC. 3. Check swing at PIN 83 (while turning A1-R1) for 60 to 70mV p-p. 4. Check swing at TP18 (while turning A1-R1) for 60 to 70 mvp-p. 5. Check swing at TP13 for 60 to 70mv p-p	----- ----- ----- ----- -----
	Input AMP offset (too much swing)	1. Check voltage across R21 for 1.12V to 1.31VDC. 2. Leave current suppress switch OFF and turn UP current suppress. Check 600 μ out for NO change.	----- 1. If not, check K3 for short. -----
	Input AMP (offset will not adjust)	1. Leave I.SUPP:OFF. Turn I.SUPP UP and check 600 ohm out for no change	1. If not, check K3 for short. -----
	Gain Adjust	NOTE: Readings assume -10V at TP11; correct readings accordingly. 1. Check TP18 for -9.992V to -9.975VDC	

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TESTS	ACTION
5.5 Cont'd			
	BIAS Compensation	2. Check TP13 for +9.936V to +10.356V DC 3. See TSP 1534 (2nd L.P. AMP). 1. Check Pin 35 for 0±15mV 2. Output should not change when changing I suppress (I. suppress off) 3. Check TP15 for 0±1mV 4. Check CR14-ANODE (while turning R52 for 0V to -5VDC range. 5. CR14 and/or Q6 leakage incorrect. 1. Check L.P. switch wiring.	1. If not, check reference circuits. 1. If not, check for K3 short 1. IF not, check V.BIAS circuit. 1. If not, check CR14 and leakage circuit.
	2nd LP Risetime		
	1st LP Risetime	1. Check L.P. switch and 6/12dB switch	
	Input Risetime [Higher Ranges (10 ⁻¹¹)]	1. Check ground plate to circuit ground for 0Ω. 2. Check shield closure to circuit ground for 0Ω.	

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TESTS	ACTION
5.5 Cont'd	Input risetime [Lower ranges (10^{-8})]	3. Check accelerator plate to: a. PIN 83 for 100Ω (10^{-8} thru 10^{-10}) b. PIN 74 for 100Ω (10^{-11} A/V). 4. Disconnect cables and check chassis ground to PIN 97 for 10Ω. 5. Reconnect signal and check Q29 drain for 2mV AC max. 6. Connect TP11 to E6 and check PIN 83 for 100mV max. 7. Check for ungrounded components going through the accelerator plate. 8. Check any wire entering the front end 2mV AC max. 1. Make certain input test jig (shielded capacitor) is connected directly to input - NO COAX ALLOWED. 2. Check Q29 drain for 2mVAC max. 3. Check continuities as in (higher ranges) above. 4. Check for ungrounded components going through the accelerator plate.	

TEST FUNCTION	REFERENCE TO	BLOCK ISOLATION TESTS	ACTION
5.5 Contd	Transformer Hum	1. Check chassis ground to circuit ground for 10Ω. 2. Check battery charge current ($\pm$) for 120ma Max. 3. Remove transformer from 1211 case and check hum. 4. Activate gate input (shorting cap) and check hum. 5. Disconnect Pins 94,95(P22) and ground pin 95 at TP20, then check hum.	----- 1. If ok, or better, try new XFMR. ----- 1. If ok, check if Q28 drains is 0-5Ω to ground. ----- ----- -----

REPLACEABLE PARTS

6.1 INTRODUCTION

This section contains the information needed for ordering replacement parts.

6.2 REFERENCE DESIGNATIONS AND ABBREVIATIONS

Table 6.1 is a list of reference designations and abbreviations.

6.3 REPLACEABLE PARTS

Table 6.2 lists parts in alphabetical order of their reference designations with locations and descriptions for each part.

6.3.1 EXPLANATION OF LOCATION COLUMN

Each page of Table 6.2 has at the top of the page the description and the ITHACO drawing Number for the parts listed.

The location code is broken down as follows:

LOCATION		The first digit or (digits) is the page number of
Sch	Asm	the schematic. The letter and digit following
3D9	C9	locate the part on that particular schematic.

The letter and number under the assembly column locate the part on the assembly drawing.

6.4 CODE LIST OF MANUFACTURERS

Table 6.3 is a Code List of Manufacturers. The manufacturer's code is given with each part. If a code number is missing, the part is a standard designation and is available from many manufacturers.

REFERENCE DESIGNATIONS

A	assembly subassembly, separable or reparable	H	hardware		plug, electrical (connector, movable portion)
AR	amplifier	HR	heater lamp, infrared	PS	power supply
AT	attenuator pad termination	HS	handset	Q	transistor
B	blower motor synchro	HY	network, hybrid circuit	R	potentiometer resistor
BT	battery	J	connector, receptacle, electrical disconnecting device	RT	lamp, resistance resistor, current regulating resistor, thermal thermistor
C	capacitor		receptacle (connector, stationary portion)	RV	resistor, voltage sensitive varistor, symmetrical
CB	circuit breaker	K	relay	S	switch thermostat
CP	adapter, connector coupling (aperture, loop or probe) junction (coaxial or waveguide)	L	coil (all not classified as transformers) inductor	T	transformer
CR	diode rectifier	M	clock counter, electrical meter oscilloscope oscilloscope recorder, elapsed time register, message strain gage thermometer timer, electric	TB	strip, terminal terminal board
DS	alarm indicator (excluding meter)	MK	microphone	TC	thermocouple
E	antenna arrestor, lightning bimetallic strip cell, aluminum or electrolytic contact core, inductor core, memory core, transformer Hall effect device insulator loop antenna magnet, permanent part, miscellaneous electrical post, binding shield, electrical terminal (individual)	MP	frame gyroscope interlock, mechanical mechanical part mounting (not electrical circuit, not a socket) part, miscellaneous mechanical (bearing, coupling, gear, shaft) part, structural reed, vibration tuning fork	TP	test point
F	fuse	MT	transducer transducer, mode	U	integrated circuit package
FL	filter	P	connector, plug, electrical disconnecting device (connector, plug)	V	cell, light-sensitive, photo- emissive electron tube
G	chopper, electronic generator			W	cable cable assembly (with connectors) wire
				WT	tiepoint, wiring
				X	fuseholder lampholder socket
				Y	crystal unit, piezoelectric

ABBREVIATIONS

A	ampere	GE	germanium	N	nano (10^{-9})	RF	radio frequency
AC	alternating current	GL	glass	N/C	normally closed	RMS	root-means-square
ALUM	aluminum	GND	ground	NE	neon	S-B	slow-blow
AMPL	amplifier			N/O	normally open	SCR	screw
ASSY	assembly	H	henries	NPO	negative positive zero	SE	selenium
BP	bandpass	HPF	high-pass filter	NSR	not separately replaceable	SEC	second
CAL	calibration	HR	hour			SECT	section(s)
CAR	carbon	Hz	hertz	OSC	oscillator	SEMICON	semiconductor
CCW	counterclockwise	IF	intermediate frequency	OP	operational	SI	silicon
CER	ceramic	INS	insulation(ed)	PC	printed circuit	SIL	silver
CKT	circuit	INT	internal	PF	picofarads 10^{-12} farads	SL	slide
COMP	composition	K	kilo = 1000	PIV	peak inverse volt voltage	SOL	solid
CRT	cathode-ray tube	LED	light emitting diode	P/P	part of	SPL	special
CW	clockwise	LIN	linear taper	PPM	parts per million	TA	tantalum
dB	decibel	LOG	logarithmic taper	POLY	polystyrene	TGL	toggle
DC	direct current	LPF	low-pass filter	POLYCARB	poly carbonate	TOL	tolerance
DET	detector			POS	position(s)	TRIM	trimmer
DVM	digital voltmeter	M	Millo 10^{-3}	POT	potentiometer	μ	micro 10^{-6}
ELECT	electrolytic	MEG	meg 10^6	P-P	peak-to-peak	V	volt
ENCAP	encapsulated	METFLM	metal film	RC	resistor capacitor network	VAR	variable
EXT	external	MFR	manufacturer	RECT	rectifier	VDCW	dc working volts
F	farads	MINAT	miniature	REF	reference	VCO	voltage controlled oscillator
FET	field effect transistor	MOM	momentary mounting			W/	with
FREQ	frequency	MTG	"mylar" film			W	watts
FXD	fixed	MYFLM				WW	wirewound
						W/O	without

TABLE 6.1 LIST OF REFERENCE DESIGNATIONS AND ABBREVIATIONS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			CAPACITORS			
C2	1-C1	B3	10pF, 500V, 5%	811581056	17	CD15CD100J03
C3	1-C2	B3	10pF, 500V, 5%	811581056	17	CD15CD100J03
C4	1-B3	C3	47pF, 1000V, 20%	811572005	48	10TS-Q47
C5	1-D2	D3	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C6	1-H1	B5	.01μF, 500V, 2 %	811570019	48	5GAS-S10
C7	1-G2	B5	47μF, 20V, 10%	811504021	48	196D-476-9020-LA3
C8	1-B6	C4	.01μF, 500V, 20%	811570019	48	5GAS-S10
C9	1-F5	D3	470pF, 1000V, 20%	811572015	48	10TS-T47
C10	1-E5	D4	100pF, 500V, 5%	811581008	17	CD15FD101J03
C11	1-B7	C5	47μF, 20V, 10%	811504021	48	196D-476-9020-LA3
C12	1-B8	C5	0.47μF, 35V, 10%	811501191	48	150D474X9035A2
C13	1-E6	D5	.01μF, 500V, 20%	811570019	48	5GAS-S10
C14	1-E8	D5	0.47μF, 35V, 10%	811501191	48	150D474X9035A2
C15	1-G7	D5	47μF, 20V, 10%	811504021	48	196D-476-9020-LA3
C16	2-D2	B3	1.5μF, 100V, 5%	811553022	104	D1-155D
C17	2-F5	E4	470pF, 500V, 5%	811581014	17	CD15FD471J03
C18	2-G4	B3	.1μF, 200V, 10%	811540065	22	626B1C104K
C19	2-G6	B4	.01μF, 500V, 20%	811570019	48	5GAS-S10
C20	2-B7	B6	150pF, 1000V, 20%	811572012	48	10TS-T15
C21	2-C7	B6	100pF, 500V, 5%	811581008	17	CD15FD101J03
C22	2-C7	B6	270pF, 500V, 5%	811581025	17	CD15FD271J03
C23	2-C8	B6	.01μF, 500V, 20%	811570019	48	5GAS-S10
C24	2-C9	B7	.01μF, 500V, 20%	811570019	48	5GAS-S10
C25	2-D7	B6	.01μF, 500V, 20%	811570019	48	5GAS-S10
C26	2-E8	B7	.01μF, 500V, 20%	811570019	48	5GAS-S10
C27	2-E9	B7	.01μF, 500V, 20%	811570019	48	5GAS-S10
C28	3-A2	F6	2200pF, 250V, 10%	811570028	48	2SS-D22
C29	3-A2	F6	120pF, 500V, 1%	811581080	79	DM15D121F
C30	3-A3	F5	470pF, 500V, 5%	811581014	17	CD15FD471J03
C31	3-A3	F6	1500pF, 500V, 1%	811581070	17	CD19FD157F03
C32	3-A3	F6	.005μF, 400V, 5%	811553026	57	D4-502
C33	3-A4	F6	.015μF, 100V, 5%	811551037	28	61F10AC332
C34	3-A4	F6	.05μF, 200V, 5%	811553025	57	D2-503
C35	3-A4	F6	0.15μF, 200V, 5%	811553024	57	D2-1540

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			CAPACITORS (Continued)			
C36	3-A4	F5	0.5μF, 200V, 5%	811553023	57	D2-504D
C37	3-A4	F6	1.5μF, 100V, 5%	811553022	104	D1-155D
C38	3-A5	F5	5μF, 100V, 5%	811553027	57	D1-505D
C39	3-A6	F4	18pF, 500V, 5%	811581027	17	CD15CD180J03
C40	3-A6	F4	120pF, 500V, 1%	811581080	79	DM15D121F
C41	3-A6	F3	470pF, 500V, 5%	811581014	17	CD15FD471J03
C42	3-A6	F3	1500pF, 500V, 1%	811581070	17	CD19FD157F03
C43	3-A7	F3	.005μF, 400V, 5%	811553026	57	D4-502
C44	3-A7	F2	.015μF, 100V, 5%	811551037	28	61F10AC332
C45	3-A7	F3	.05μF, 200V, 5%	811553025	57	D2-503
C46	3-A7	F2	0.15μF, 200V, 5%	811553024	57	D2-154D
C47	3-A8	F2	0.5μF, 200V, 5%	811553023	57	D2-504D
C48	3-A8	F3	1.5μF, 100V, 5%	811553022	104	D1-155D
C49	3-A8	F2	5μF, 100V, 5%	811553027	57	D1-505D
C50	3-C1	E7	.01μF, 500V, 20%	811570019	48	5GAD-S10
C51	3-C2	E7	22pF, 1000V, 20%	811572003	48	10TS-Q22
C52	3-D3	F7	22pF, 1000V, 20%	811572003	48	10TS-Q22
C53	3-C4	E5	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C54	3-C4	E5	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C55	3-B4	E4	10pF, 1000V, 20%	811572001	48	10TS-Q10
C56	3-C4	E4	VAR 5.5-18pF	811590008	25	538-002A5.5-18
C57	3-E2	F7	100pF, 1000V, 20%	811572011	48	10TS-T10
C58	3-F2	F8	.01μF, 500V, 20%	811570019	48	5GAS-S10
C59	3-F5	F7	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C60	3-C7	G3	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C61	3-C7	G4	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C62	3-D7	G3	22pF, 500V, ±1/2pF	811581066	17	CD10ED220D03
C63	3-D8	G3	150pF, 1000V, 20%	811572012	48	10TS-T15
C64	3-C8	F4	VAR 5.5-18pF	811590008	25	538-002A5.5-18
C65	3-C8	F4	10pF, 1000V, 20%	811572001	48	10TS-Q10
C66	3-C9	G3	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C67	3-E7	F3	.01μF, 500V, 20%	811570019	48	5GAS-S10
C68	3-E9	G3	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C69	5-F2	B8	.01μF, 500V, 20%	811570019	48	5GAS-S10
C70	5-H2	B8	.01μF, 500V, 20%	811570019	48	5GAS-S10

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
CAPACITORS (continued)						
C71	5-G3	B9	.01μF, 500V, 20%	811570019	48	5GAS-S10
C72	4-D3	D9	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C73	4-C4	D9	.047μF, 100V, 5%	811551013	48	61F19AC473
C74	4-D6	D7	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C75	4-D6	C8	.01μF, 500V, 20%	811570019	48	5GAS-S10
C76	4-E6	D7	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C77	4-E6	D7	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C78	4-D7	D8	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C79	4-D7	C7	470pF, 1000V, 20%	811572015	48	10TS-T47
C80	4-F7	C6	470pF, 1000V, 20%	811572015	48	10TS-T47
C81	4-E2	D9	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C82	1-D1	D5	100pF, 1000V, 20%	811572011	48	10TS-T10
C83	2-G4	D6	100pF, 1000V, 20%	811572011	48	10TS-T10
C84	4-G5	D5	.01μF, 500V, 20%	811570019	48	5GAS-S10
C85	2-H2	C2	.047μF, 50V, 20%	811570020	25	8121-050-651-473M
C86	1-A7	B5	15μF, 20V, 10%	811504020	48	196D-156X9020KA1
C87	2-G5	B4	.01μF, 500V, 20%	811570019	48	5GAS-S10
C89	2-F5	D4	.047μF, 100V, 5%	811551013	28	61F19AC473
C90	1-E5	D4	22pF, 500V, ±1/2pF	811581066	17	CD10ED220D03
C91	2-G5	B4	470pF, 1000V, 20%	811572015	48	10TS-T47
DIODES						
CR1	1-C1	B4	IN4148	818100003		IN4148
CR2	1-C2	C3	IN4148	818100003		IN4148
CR3	1-B2	C3	IN4148	818100003		IN4148
CR4	1-G2	B5	IN4148	818100003		IN4148
CR5	1-G2	B5	IN4148	818100003		IN4148
CR6	1-H2	B5	IN4148	818100003		IN4148
CR7	1-H2	B5	IN823A (6.2V)	818175002		IN823A
CR8	1-C5	C4	IN4148	818100003		IN4148
CR9	1-C6	C5	IN4148	818100003		IN4148
CR10	1-D6	C5	IN4148	818100003		IN4148

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			DIODES (Continued)			
CR11	2-D2	D3	Selected (D PAD 50)	A86153P1	31	A86153P1
CR12	2-D2	B5	IN4005	818100007		IN4005
CR13	2-D2	B5	IN4005	818100007		IN4005
CR14	2-H3	C2	Selected (D PAD 50)	A86153P2	31	A86153P2
CR15	2-G3	D6	IN4148	818100003		IN4148
CR16	2-H6	B4	IN4148	818100003		IN4148
CR17	2-D8	B6	IN4148	818100003		IN4148
CR18	2-D8	B6	IN4148	818100003		IN4148
CR19	2-D8	B6	IN4148	818100003		IN4148
CR20	2-D8	B6	IN4148	818100003		IN4148
CR21	2-D8	B6	IN4148	818100003		IN4148
CR24	3-F2	F8	IN4148	818100003		IN4148
CR25	3-F2	F8	IN4148	818100003		IN4148
CR26	3-D8	G3	IN4148	818100003		IN4148
CR27	3-D8	G3	IN4148	818100003		IN4148
CR28	3-D8	G3	IN4148	818100003		IN4148
CR29	3-D8	G3	IN4148	818100003		IN4148
CR30	3-D8	G3	IN4148	818100003		IN4148
CR31	5-E1	B8	IN4148	818100003		IN4148
CR32	5-E1	B8	IN4148	818100003		IN4148
CR34	5-G1	C8	IN4148	818100003		IN4148
CR35	5-G1	C8	IN4148	818100003		IN4148
CR37	5-F3	B9	IN4148	818100003		IN4148
CR38	5-F3	B9	IN4148	818100003		IN4148
CR39	5-G3	C9	IN4148	818100003		IN4148
CR40	5-G3	C9	IN4148	818100003		IN4148
CR42	4-C2	D8	IN827A (6.2V) Zener	818175003		IN827A
CR43	4-F4	D5	IN4148	818100003		IN4148
CR44	4-F4	D5	IN4148	818100003		IN4148
CR45	4-D9	D5	IN4148	818100003		IN4148

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
DIODES (continued)						
CR46	3-G5	D6	IN4148	818100003		IN4148
CR47	3-G5	E6	IN4148	818100003		IN4148
CR48	2-G5	D6	IN4148	818100003		IN4148
CR49	3-G6	E6	IN4148	818100003		IN4148
J1		F6	Socket, 14 pin dip	812129113	101	CA-14S-105D
J2		E6	Socket, 14 pin dip	812129113	101	CA-14S-105D
K1	1-C2	B3	Relay	814500022	106	1A12AHH-X
K2-L	2-G3	E2	Coil, Relay Shielded	A88493P1	31	A88493P1
K2-S	2-G3	E2	Reed Switch	A88630P1	31	A88630P1
K3-L	4-D9	E2	Coil, Relay Shielded	A88493P1	31	A88493P1
K3-S	4-D9	E2	Reed Switch	A88630P1	31	A88630P1
TRANSISTORS						
Q1	1-B2	C3	2N3906	818203906		2N3906
Q2	1-D1	D5	TIS97	818700046		TIS97
Q3	1-D1	D5	2N3904	818203904		2N3904
Q4	1-C3	D2	2N3958	818203958		2N3958
Q5	1-C4	C3	AD821	818700045		AD821
Q6	1-D3	D2	2N6484 (Select)	A86152P2	31	A86152P2
Q7	1-E2	D3	2N5087	818205087		2N5087
Q8	1-E3	B3	2N3906	818203906		2N3906
Q9	1-F2	B2	2N3904	818203904		2N3904
Q10	1-F3	C2	2N3904	818203904		2N3904
Q11	1-G2	B5	2N3906	818203906		2N3906
Q12	1-G2	B5	2N3904	818203904		2N3904
Q13	1-D5	C4	AD821	818700045	5	AD821
Q14	1-D4	C4	2N3906	818203906		2N3906
Q15	1-D5	C4	2N3906	818203906		2N3906

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			TRANSISTORS (continued)			
Q16	1-E4	D4	2N3904	818203904		2N3904
Q17	1-E5	D4	2N3904	818203904		2N3904
Q18	1-F5	C4	2N3904	818203904		2N3904
Q19	1-B5	C4	2N3904	818203904		2N3904
Q20	1-B6	C5	2N3906	818203906		2N3906
Q21	1-B7	C5	2N2219	818202219		2N2219
Q22	1-G7	C5	2N3904	818203904		2N3904
Q23	1-C7	C5	2N3906	818203906		2N3906
Q24	1-D6	D4	2N3906	818203906		2N3906
Q25	1-D7	C5	2N2905	818202905		2N2905
Q26	2-G4	D6	2N3904	818203904		2N3904
Q27	2-G4	C6	TIS97	818700046	55	TIS97
Q28	2-E2	B4	TIS75	818700009	55	TIS75
Q29	2-H4	B3	TIS75	818700009	55	TIS75
Q30	2-H5	B4	2N3904	818203904		2N3904
Q31	2-G6	B4	TIS75	818700009	55	TIS75
Q32	2-G6	B5	2N3904	818203904		2N3904
Q33	2-C8	B7	2N2219	818202219		2N2219
Q34	2-E8	B7	2N3904	818203904		2N3904
Q35	2-E8	B7	2N2905	818202905		2N2905
Q36	3-C1	E7	2N3904	818203904		2N3904
Q37	3-C2	E6	TIS75	818700009	55	TIS75
Q38	3-C2	E6	TIS75	818700009	55	TIS75
Q39	3-D1	E7	2N3906	818203906		2N3906
Q40	3-D2	E7	2N3906	818203906		2N3906
Q41	3-E1	F7	2N3904	818203904		2N3904
Q42	3-E2	F7	2N3904	818203904		2N3904
Q43	3-G1	F9	2N3904	818203904		2N3904
Q44	3-D5	G4	TIS75	818700009	55	TIS75
Q45	3-D6	G4	TIS75	818700009	55	TIS75
Q46	3-D6	G4	TIS75	818700009	55	TIS75
Q47	3-E6	G4	TIS75	818700009	55	TIS75
Q48	3-E5	G4	TIS75	818700009	55	TIS75
Q49	3-C6	G4	U402	818700043	108	U402
Q50	3-E7	F4	2N3904	818203904		2N3904

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			TRANSISTORS (Continued)			
Q51	3-E8	F3	2N3904	818203904	55	2N3904
Q52	3-C8	G3	2N2219	818202219		2N2219
Q53	3-D9	F3	2N2905	818202905		2N2905
Q54	5-E1	B8	2N3904	818203904		2N3904
Q55	5-F2	B8	2N3904	818203904		2N3904
Q56	5-G1	C8	2N3906	818203906		2N3906
Q57	4-C2	D8	2N3904	818203904		2N3904
Q58	4-E3	D9	2N3906	818203906		2N3906
Q59	4-E3	E9	2N3904	818203904		2N3904
Q60	4-D4	D9	TIS75	818700009		TIS75
Q61	4-E6	C8	2N3904	818203904	55	2N3904
Q62	4-E7	C7	2N3904	818203904		2N3904
Q63	4-D7	C7	2N3906	818203906		2N3906
Q64	4-F6	C8	2N3906	818203906		2N3906
Q65	4-E7	C7	2N3906	818203906		2N3906
Q66	4-F7	C7	2N3904	818203904		2N3904
Q67	4-G5	D5	2N3904	818203904		2N3904
Q68	4-G5	D5	TIS97	818700046		TIS97
Q69	3-C3	E7	2N3904	818203904		2N3904
Q70	1-D5	C4	2N3906	818203906		2N3906
Q71	2-H5	B4	2N3904	818203904		2N3904
Q72	1-B7	B5	2N3904	818203904		2N3904
Q73	1-F7	C5	2N3906	818203906		2N3906

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS			
			All resistors not otherwise designated are 1/4W, 5%, Comp * 1/8W, 1%, Metflm ** 1/8W, 0.1%, Metflm ***1/10W, 1%, Temp Stable, Metflm			
R1	1-B3	C3	75.0 ohm *	817219750		RN60D
R2	1-B3	C3	7.50K *	817211750		RN60D
R3	1-B2	C3	7.50K *	817211750		RN60D
R4	1-B2	C3	7.50K *	817211750		RN60D
R5	1-C3	C3	56 ohm	817007560		RC07
R6	1-B2	C3	75.0 ohm *	817219750		RN60D
R7	1-B3	C3	11.0K *	817212110		RN60D
R8	1-B4	C3	11.0K *	817212110		RN60D
R9	1-C3	C3	56 ohm	817007560		RC07
R10	1-D1	D4	33K	817007333		RC07
R11	1-D1	D5	133 ohm *	817210133		RN60D
R12	1-D2	D3	1.62K *	817211162		RN60D
R13	1-D2	D3	20K (Pot)	817801138	29	72PR20K
R14	1-E2	D2	100 ohm	817007101		RC07
R15	1-E2	D2	42.2 ohm *	817219422		RN60D
R16	1-E2	D2	42.2 ohm *	817219422		RN60D
R17	1-E3	B3	1.47K *	817211147		RN60D
R18	1-F2	B2	1.47K *	817211147		RN60D
R19	1-F3	B2	1.47K *	817211147		RN60D
R20	1-G2	B5	5.11K *	817211511		RN60D
R21	1-G2	B5	1.62K *	817211162		RN60D
R22	1-G2	B5	10K	817007103		RC07
R23	1-H2	B5	8.25K *	817211825		RN60D
R24	1-H2	B5	8.25K *	817211825		RN60D
R25	1-D4	C3	12 ohm	817007120		RC07
R26	1-B4	C4	422 ohm *	817210422		RN60D
R27	1-B5	C4	1K	817007102		RC07
R28	1-B5	C4	5.11K *	817211511		RN60D
R29	1-C5	C4	42.2 ohm *	817219422		RN60D
R30	1-C5		42.2 ohm *	817219422		RN60D

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R31	1-C5	C4	33K	817007333		RC07
R32	1-C5	C3	12 ohm	817007120		RC07
R33	1-D5	C4	1K	817007102		RC07
R34	1-D6	D4	100 ohm	817007101		RC07
R35	1-D6	D4	681 ohm *	817210681		RN60D
R36	1-F4	D4	511 ohm *	817210511		RN60D
R37	1-F5	D4	511 ohm *	817210511		RN60D
R38	1-F5	D4	12.1K *	817212121		RN60D
R39	1-B6	C4	681 ohm *	817210681		RN60D
R40	1-B7	C5	4.7K	817007472		RC07
R41	1-B6	C5	1K	817007102		RC07
R42	1-B7	C5	12 ohm	817007120		RC07
R43	1-B6	C5	100 ohm	817007101		RC07
R44	1-B6	C4	100 ohm	817007101		RC07
R45	1-C7	C5	12 ohm	817007120		RC07
R46	1-C7	C5	12 ohm	817007120		RC07
R47	1-D6	C5	100 ohm	817007101		RC07
R48	1-E6	D5	681 ohm *	817210681		RN60D
R49	1-E7	D5	56 ohm	817007560		RC07
R50	1-F7	D5	4.7K	817007472		RC07
R51	2-C2	C2	681 ohm *	817210681		RN60D
R52	2-H2	B3	100K, 10% (Pot)	817801136	29	72PR100K
R53	2-G5	B4	33K	817007333		RC07
R54	2-G2	B3	100K, 1/8W, 1%, 25ppm	817200052		RN55E-1003F
R55	2-G2	B3	100K, 1/8W, 1%, 25ppm	817200052		RN55E-1003F
R56	2-H2	B3	464K *	817213464		RN60D
R57	2-H2	B2	464K *	817213464		RN60D
R58	2-G3	C6	100 ohm	817007101		RC07
R59	2-G3	B3	47K	817007473		RC07
R60	2-G4	C6	33K	817007333		RC07
R61	2-F4	D4	8.2 ohm	817007829		RC07
R62	2-F4	D4	6.282K, 1/8W, 0.1%, 100ppm	817261185	57	CEA-TO-6282 1/8 1%
R63	2-F4	D4	10 ohm *	817219100		RN60D
R64	2-F5	D4	690.2 ohm, 1/4W, 0.1%, 50ppm	817200037	57	CCA-T2-690.2 ohm
R65	2-F5	D4	614.8 ohm, 1/4W, 0.1%, 50ppm	817200038	57	CCA-T2-614.8 ohm

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R66	2-F5	D4	292.1 ohm, 1/4W, 0.1%, 25ppm	817200039	57	CCA-T9-292.1 ohm
R67	2-F6	D4	698.0 ohm, 1/4W, 0.1%, 50ppm	817200040	57	CCA-T2-698.0 ohm
R68	2-E2	B4	220K	817007224		RC07
R69	2-G5	B4	4.7K	817007472		RC07
R70	2-G5	B4	1M	817007105		RC07
R71	2-G5	B4	1K	817007102		RC07
R72	2-G5	B5	1M	817007105		RC07
R73	2-G5	B5	220K	817007224		RC07
R74	2-H5	B4	220K	817007224		RC07
R75	2-G6	B4	100 ohm	817007101		RC07
R76	2-H6	B4	100K	817007104		RC07
R77	2-B7	B7	2.162K, 1/8W, 0.1%, 100ppm	817261016	63	REA 1/*, 2.162K C1
R78	2-B8	D7	100 ohm	817007101		RC07
R79	2-C7	B6	22 ohm	817007220		RC07
R80	2-C8	B6	100 ohm	817007101		RC07
R81	2-C8	B7	100 ohm	817007101		RC07
R82	2-C7	B6	1K	817007102		RC07
R83	2-C7	B7	100 ohm	817007101		RC07
R84	2-C7	B6	464K *	817213464		RN60D
R85	2-D7	B6	2.162K, 1/8W, 0.1%, 100ppm	817261016	63	REA 1/8, 2.162KC1
R86	2-C7	B6	316 ohm *	817210316		RN60D
R87	2-C7	B6	100 ohm	817007101		RC07
R88	2-D7	B6	100K, 10%, (Pot)	817801136	29	72PR100K
R89	2-C8	B7	18 ohm	817007180		RC07
R90	2-D9	B7	18 ohm	817007180		RC07
R91	2-D9	B7	18 ohm	817007180		RC07
R92	2-D8	B7	18 ohm	817007180		RC07
R93	2-D8	B7	100 ohm	817007101		RC07
R94	2-E7	B7	1K	817007102		RC07
R95	2-E8	B7	4.7K	817007472		RC07
R96	2-E9	B7	100 ohm	817007101		RC07
R97	3-A5	F5	470K	817007474		RC07
R98	3-A5	G5	470K	817007474		RC07
R99	3-A8	F2	470K	817007474		RC07
R100	3-A8	F2	470K	817007474		RC07

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (continued)			
R101	3-C1	E7	22 ohm	817007220		RC07
R102	3-D1	E8	10K	817007103		RC07
R103	3-C2	E7	18K	817007183		RC07
R104	3-C2	E7	100K	817007104		RC07
R105	3-D2	E7	220K	817007224		RC07
R106	3-D2	E8	10K	817007103		RC07
R107	3-C2	E5	19.6K *	817212196		RN60D
R108	3-C3	E5	19.6K *	817212196		RN60D
R109	3-C2	E7	18K	817007183		RC07
R110	3-C3	E5	316 ohm *	817210316		RN60D
R111	3-C3	F5	464K *	817213464		RN60D
R112	3-D3	E7	220K	817117224		RC07
R113	3-C3	F4	50K (POT)	817801135	29	68WR50K
R114	3-B4	E5	100 ohm	817007101		RC07
R115	3-C4	E5	100 ohm	817007101		RC07
R116	3-B4	E5	19.6K *	817212196		RN60D
R117	3-B4	E5	316 ohm *	817210316		RN60D
R118	3-E1	F7	33K	817007333		RC07
R119	3-E2	F7	33K	817007333		RC07
R120	3-F1	F9	100K	817117104		RC07
R121	3-F2	F9	47K	817007473		RC07
R122	3-F2	F9	4.7K	817007472		RC07
R123	3-G2	F9	33K	817007333		RC07
R124	3-G2	E8	10 ohm, 1W, 5%, FP	817003100	57	BW 20F-10 ohm
R125	3-F2	F8	4.7K	817007472		RC07
R126	3-F3	F8	100 ohm	817007101		RC07
R127	3-F3	F8	33K	817007333		RC07
R128	3-F3	F8	33K	817007333		RC07
R129	3-C5	F4	500 ohm (POT)	817801137	29	72PR500 ohm
R130	3-C5	F4	75.03K, 1/8W, 0.1%, 100ppm	817261132	63	RE 1/4 C-1 75.03K
R131	3-C6	F4	80.00K, 1/8W, 0.1%, 100ppm	817261085	64	CEA, T-O, 80.0K
R132	3-C5	F4	14.07K, 1/8W, 0.1%, 100ppm	817261112	57	RE 1/4C-114.07K
R133	3-C5	F5	64.60K, 1/8W, 0.1%, 100ppm	817261184	57	CEA-TO-64.6K 1/8 1%
R134	3-D5	G5	33K	817007333		RC07
R135	3-D5	F4	33K	817007333		RC07

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R136	3-D5	F5	6.448K, 1/8W, 0.1%, 100ppm	817261190	57	CEA-TO-6.448 1/8 1
R137	3-E5	G7	33K	817007333		RC07
R138	3-F5	G7	33K	817007333		RC07
R139	3-F5	F7	100 ohm	817007101		RC07
R140	3-F4	F7	33K	817007333		RC07
R141	3-G4	F7	33K	817007333		RC07
R142	3-F4	F7	33K	817007333		RC07
R143	3-F5	F7	33K	817007333		RC07
R144	3-D6	F4	50K (POT)	817801135		
R145	3-D6	G4	287K *	817213287		RN60D
R146	3-C6	G4	422 ohm *	817210422		RN60D
R147	3-D6	F4	7.50K *	817211750		RN60D
R148	3-C7	G3	56 ohm	817007560		RC07
R149	3-C7	G4	100 ohm	817007101		RC07
R150	3-D7	F4	7.50K *	817211750		RN60D
R151	3-C8	G3	470ohm, 1/2W, 5%	817020471		RC20
R152	3-E7	F4	2.61K *	817211261		RN60D
R153	3-E7	F3	1K	817007102		RC07
R154	3-E8	F3	1K	817007102		RC07
R155	3-B8	G3	75.0K *	817212750		RN60D
R156	3-B8	G3	287K *	817213287		RN60D
R157	3-C9	G3	56 ohm	817007560		RC07
R158	3-B9	G2	604 ohm, 1W, 1%	817200045	57	CEC-TO-604-1%
R159	3-C9	G2	604 ohm, 1W, 1%	817200045	57	CEC-TO-604-1%
R160	3-C8	G3	100 ohm	817007101		RC07
R161	3-D9	G3	18 ohm	817007180		RC07
R162	3-D9	G2	22 ohm	817007220		RC07
R163	3-D8	F3	100 ohm	817007101		RC07
R164	3-E8	F3	2.2K	817007222		RC07
R165	3-E9	F3	56 ohm	817007560		RC07
R166	3-D8	G3	18 ohm	817007180		RC07
R167	5-F2	B8	100 ohm	817007101		RC07
R168	5-F2	B8	1M	817007105		RC07
R169	5-E2	B8	19.6K *	817212196		RN60D
R170	5-G2	C8	7.50K *	817211750		RN60D

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R171	5-G2	C8	100 ohm	817007101		RC07
R172	5-H2	C8	1M	817007105		RC07
R173	5-G2	C9	287K *	817213287		RN60D
R174	5-G2	C9	470K	817007474		RC07
R175	5-G2	C9	220K	817007224		RC07
R176	5-H2	C8	19.6K *	817212196		RN60D
R177	5-F3	B9	220K	817007224		RC07
R178	5-G3	B9	18K	817007183		RC07
R179	5-G4	B9	1M	817007105		RC07
R180	5-F4	B9	2.2K, 1W, 5%	817032222		RC32
R181	4-C2	D8	12.1K *	817212121		RN60D
R182	4-D2	D8	1.47K *	817211147		RN60D
R183	4-D1	D8	22K	817007223		RC07
R184	4-C3	D9	19.6K, 1/4W, 1%, 25ppm	817200055		RN60E1962F
R185	4-C3	D9	5K (POT)	817801133	29	68WR5K
R186	4-C3	D9	31.6K, 1/4W, 1%, 25ppm	817200043		RN60E3162F
R187	4-E3	D9	31.6K, 1/4W, 1%, 25ppm	817200043		RN60E3162F
R189	4-C4	D9	31.6K, 1/4W, 1%, 25ppm	817200043		RN60E3162F
R190	4-C4	D9	22 ohm	817007220		RC07
R191	4-D4	E8	18K	817007183		RC07
R192	4-D2	D9	22K	817007223		RC07
R193	4-D3	D9	6.8K	817007682		RC07
R194	4-E2	D9	10K	817007103		RC07
R195	4-E3	D9	10K	817007103		RC07
R196	4-F3	E8	100K	817007104		RC07
R197	4-F3	E8	100K	817007104		RC07
R198	4-E5	D7	19.6K, 1/4W, 1%, 25ppm	817200055		RN60E1962F
R199	4-E5	D7	22 ohm	817007220		RC07
R200	4-E5	D7	22 ohm	817007220		RC07
R201	4-D6	D8	100 ohm	817007101		RC07
R202	4-C6	D7	1.78K, 1/4W, 1%, 25ppm	817200044		RN60E1781F
R203	4-C6	D8	19.6K, 1/4W, 1%, 25ppm	817200055		RN60E1962F
R204	4-D6	D8	22 ohm	817007220		RC07
R205	4-D6	C8	10K	817007103		RC07

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS (Continued)			
R206	4-D7	C8	22 ohm	817007220		RC07
R207	4-D7	C7	1K	817007102		RC07
R208	4-E7	C7	56 ohm	817007560		RC07
R209	4-E6	C8	22K	817007223		RC07
R210	4-E7	C8	6.8K	817007682		RC07
R211	4-F6	D6	10K	817007103		RC07
R212	4-F7	D6	22 ohm	817007220		RC07
R213	4-F7	C7	1K	817007102		RC07
R214	4-E7	C7	56 ohm	817007560		RC07
R215	4-F5	D5	33K	817007333		RC07
R216	4-G5	D5	100 ohm	817007101		RC07
R217	3-F1	F9	100K	817007104		RC07
R218	3-D3	E7	100K	817007104		RC07
R219	3-G3	E7	22K	817007223		RC07
R221	2-C7	B6	1K	817007102		RC07
R222	2-H2	B2	4.7M	817007475		RC07
R223	1-A7	C5	75.0 ohm *	817219750		RN60D
R224	1-A7	B5	1K	817007102		RC07
R225	1-B7	B5	1K	817007102		RC07
R226	1-E5	D4	100 ohm	817007101		RC07
R227	1-F6	C5	1K	817007102		RC07
R228	1-G6	C5	1K	817007102		RC07
R229	3-C9	G2	49.9K *	817219499		RN60D
S1	3-B2	E4	Switch, Slide	815188009	2	MSS2250
			OP AMPS			
U1	2-C7	B6	NE5534	816400071	71	NE5534
U2	3-C4	E5	TL071ACP	816400073	55	TL071ACP
U3	3-D4	G7	MC14069BCP	816374069		MC14069BCP
U4	3-C7	G4	NE5534	816400071	71	NE5534
U5	5-G2	B9	μA340PC	816400072	26	μA340PC
U6	4-D4	D8	μA340PC	816400072	26	μA340PC
U7	4-E6	D7	TL071ACP	816400073	55	TL071ACP
U8	3-F2	F8	CD4093B	816374093		CD4093B

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			CAPACITORS			
C1			0.022μF, 100V, 10%, Myfilm	811551017	28	61F15AA223
C2			0.22μF, 200V, 10%, Mylar	811553008	22	W230B1C-224K
C3			0.22μF, 200V, 10%, Mylar	811553008	22	W230B1C-224K
			RESISTORS			
R1			10K, Pot, Cermet	817804103	7	3386W-1-103
R2			10K, Pot, Cermet	817804103	7	3386W-1-103
R3			4.7K	817007472		RC07
R4			10K, Pot, Cermet	817804103	7	3386W-1-103
R5			10K, Pot, Cermet	817804103	7	3386W-1-103
R6			4.7K	817007472		RC07
R7			10K, Pot, Cermet	817804103	7	3386W-1-103
R8			10K, Pot, Cermet	817804103	7	3386W-1-103
R9			4.7K	817007472		RC07

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
DS1	5-G4	F6	LED, RED	818149006	78	521-9165
DS2	5-F6	F7	LED, GREEN	818149007	78	521-9203
J1	2-C1	F6	Connector, BNC	812130110	19	30355-1
J2	3-B10	F7	Connector, BNC	812130110	19	30355-1
P6	4-E5	D3	Connector Block, 10 pos	812122510	81	65486-010
P16	4-E5	D4	Connector Block, 10 pos	812122510	81	65486-010
R1	1-F2	F6	Resistor (POT) 1K	817801115	29	78SBWR1K
S4	3-F5	F6	Switch, Rotary	A88507P1	31	A88507P1
S6	2-F3	F6	Switch, Toggle, SPDT	815111005	14	7107
S7	4-E5	F7	Switch, Toggle, DPDT	815111008	14	7203
S9	4-C5	F7	Switch, Toggle, DPDT	815111007	14	7201

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
A1	5-C3	E6	Connector, Volt Select	812120009	16	6J1
F1	5-C2	E6	Fuse 1/4A, 250V, SB	815183014	9	MDL 1/4 250V
J10	3-G1	E6	Connector, BNC	812130110	19	30355-1
J11	3-C10	E7	Connector, BNC	812130110	19	30355-1
J12	3-C10	E7	Connector, BNC	812130110	19	30355-1
J13	2-D10	E8	Connector, BNC	812130110	19	30355-1
P17	2-F1	D3	Connector Block, 6 pos	812122506	81	65486-006
R10	2-F2	E7	Resistor (POT) 20K, 15 turn	817801111	84	89PBR20K
S11	2-G1	E6	Switch, Toggle, DPDT	815111008	14	7203

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
CAPACITORS						
C1	1-D4	C4	1000μF, 50V	811530020	17	BR-1000-50
C2	1-C5	E4	1000μF, 50V	811530020	17	BR-1000-50
C3	1-C5	D3	2.2μF, 20V, 10%	811501146	48	150D225x9020A2
C4	1-D6	D4	470pF, 1000V, 10%	811572015	17	10TS-T47
C5	1-D6	D2	2.2μF, 20V, 10%	811530020	17	BR-1000-50
C6	1-F4	D4	33pF, 1000V, 10%	811572004	17	10TS-Q33
C7	1-F4	C5	.01μF, 500V, 20%	811570019	17	5GA-D10
C8	1-G4	C3	15μF, 20V, 10%	811501156	48	150D225x9020A2
C9	1-E9	C2	33pF, 1000V, 10%	811572004	17	10TS-Q33
C10	1-F9	C3	2.2μF, 20V, 10%	811530020	17	BR-1000-50
C11	1-A7	D3	470pF, 1000V, 10%	811570015	17	10TS-T47
C12	1-F7	C2	470pF, 1000V, 10%	811572015	17	10TS-T47
DIODES						
CR1	1-B4	D5	IN4005	818100007		IN4005
CR2	1-C4	D5	IN4005	818100007		IN4005
CR3	1-C4	C5	IN4005	818100007		IN4005
CR4	1-D4	C5	IN4005	818100007		IN4005
CR5	1-B7	D3	IN4005	818100007		IN4005
CR6	1-B8	E2	IN4005	818100007		IN4005
CR7	1-D7	D2	IN4005	818100007		IN4005
CR8	1-G3	C3	IN4005	818100007		IN4005
CR10	1-F5	C3	IN4005	818100007		IN4005
CR11	1-F8	C2	IN4005	818100007		IN4005
CR12	1-E8	C3	IN5234	818150073		IN5234
F1	1-C8	D2	Fuse 1.5A FA	815183013	9	AGC
F2	1-F6	D2	Fuse 1.5A FA	815183013	9	AGC
Q2	1-B7	E2	2N3904 Transistor	818203904		2N3904
Q4	1-G3	C4	2N3904 Transistor	818203904		2N3904
Q6	1-F4	C4	2N3906 Transistor	818203906		2N3906
Q7	1-E7	C2	2N3904 Transistor	818203904		2N3904

TABLE 6.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
			RESISTORS			
			All resistors not otherwise designated are 1/4W, 5%, Comp. * 1/8W, 1%, Metflm ** 1/8W, 0.1%, Metflm *** 1/10W, 1%, Temp Stable, Metflm			
R1	1-C5	D3	4.7K	817007472	57	RC07
R2	1-C6	D4	1.2 ohm	817003129		BW20F1.2 ohm
R3	1-C6	D3	10.0K *	817212100		RN60
R4	1-D6	D3	6.65K *	817211665	84	RN60
R5	1-D6	D3	2K Pot	817801110		72PR2K
R6	1-D7	D2	4.7K	817007472		RC07
R7	1-A7	E3	3.3K	817020332		RC20
R8	1-B8	E2	8.2 ohm	817007829		RC07
R9	1-B8	E2	6.8 ohm	817007689		RC07
R10	1-B6	D4	75K	817007753		RC07
R11	1-E6	C4	10.0K *	817212100	57	RN60
R12	1-G3	C3	1.2 ohm	817003129		BW20F1.2 ohm
R13	1-F3	C4	4.7K	817007472		RC07
R14	1-F4	C4	10.0K *	817212100		RN60
R15	1-E4	C4	15K	817007153		RC07
R16	1-E5	C4	15K	817007153		RC07
R17	1-E5	C4	15K	817007153		RC07
R18	1-F6	C4	4.7K	817007472		RC07
R19	1-F7	C2	8.2K	817007822		RC07
R20	1-E7	C2	8.2 ohm	817007829		RC07
R21	1-E8	C2	5.6 ohm	817007569	84	RC07
R22	1-D8	C3	2K Pot	817801110		72PR2K
R23	1-E9	C3	3.3K	817007332		RC07
R24	1-E8	C3	1K	817007102		RC07
R25	1-E8	C3	680 ohm	817007681		RC07
R26	1-F8	C3	3.3K	817007332		RC07
R27	1-E9	C2	180K	817007184		RC07
R28	1-E9	C2	470 ohm	817020471		RC20
R29	1-C6	D4	1K	817007102		RC07
R30	1-G3	C4	1K	817007102		RC07

REFERENCE DESIGNATION	LOCATION		DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER	
	SCH	ASM			CODE	PART NUMBER
R31	1-F3	C4	75K	817007753		RC07
R32	1-B7	E2	1K	817007102		RC07
R33	1-E7	C2	1K	817007102		RC07
U1	1-C5	D4	Regulator LM723CN	816400074		LM723CN
U2	1-E4	C4	Op Amp LM301A	A86050-P4	31	LM301A
U3	1-E9	C2	Op Amp LM301A	A86050-P4	31	LM301A

TABLE 6.2 REPLACEABLE PARTS

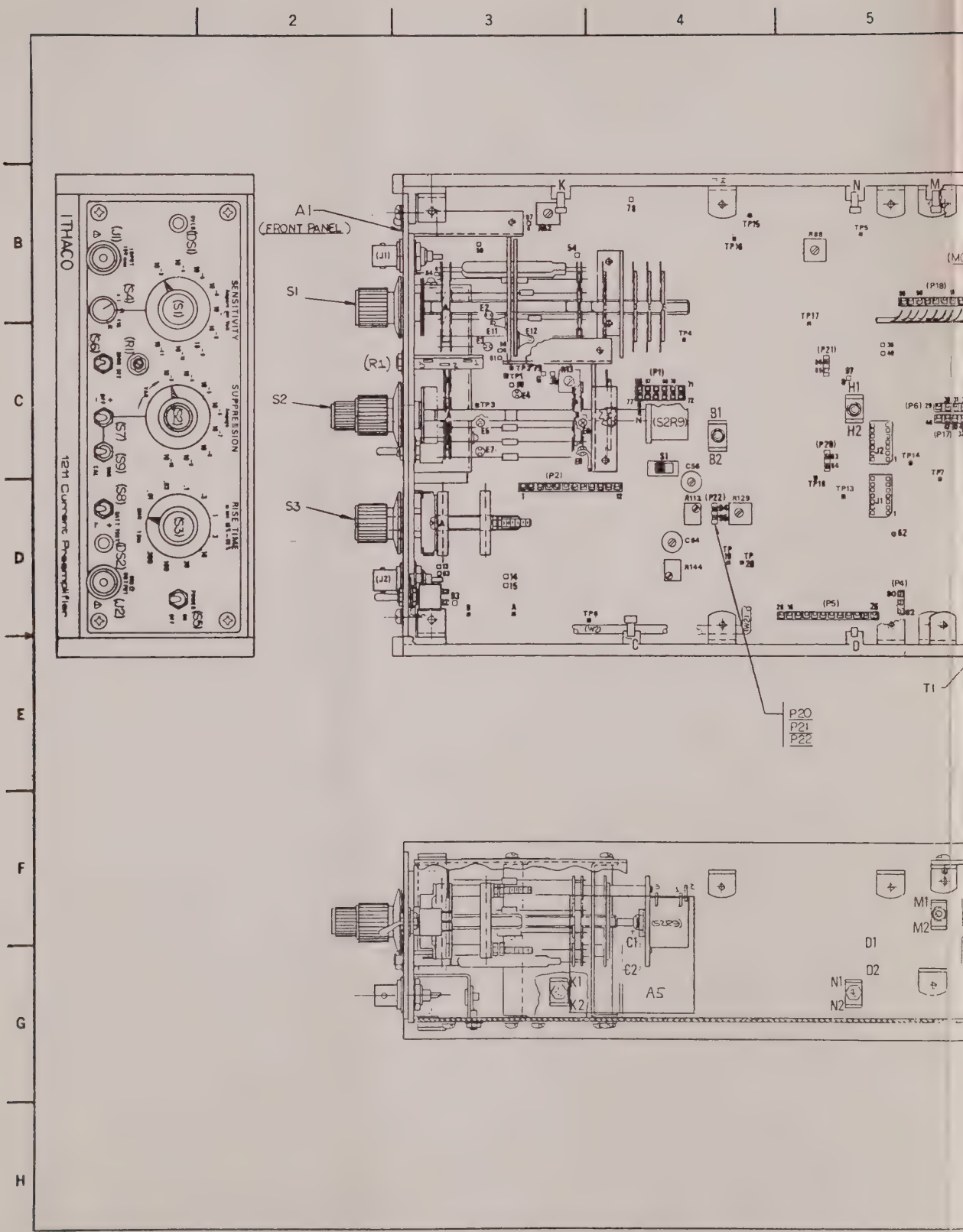
17

17

CODE LIST OF MANUFACTURERS

1	Aerovox	51	D M Steward Mfg
2	Alco Electronic Prod	52	Switchcraft
3	Allen Bradley		
4	Amphenol Connector	53	Teledyne Semiconductor
5	Analog Devices	54	Teledyne Western Wire and Cable
		55	Texas Instruments
6	Belden	56	Thermalloy
7	Bourns	57	TRW
8	Buckeye Stamping		
9	Bussman Mfg	58	United Transformer
		59	Useco
10	Cambion		
11	Cannon, ITT	60	Vactec
12	Centralab		
13	Cinch Mfg	61	Winchester Electronic
14	C & K Components		
15	Continental-Wirt Elec	62	Vishay
16	Corcom	63	ACI
17	Cornell Dubilier Elec	64	IRC
18	CTS	65	EAL
		66	AMP
19	Dage Electric	67	Clarostat Mfg
20	Delevan Electronics	68	Gould Inc
21	Dresser Systems	69	Littlefuse Inc
22	Electrocube	70	General Illumination
23	Electro Motive Mfg		
24	Electronics Applications	71	Signetrix
25	Erie Technological Products	72	Semiconductor Cir
		73	Statek
26	Fairchild Semiconductor	74	Bendix
27	Federal Screw Prod	75	Burndy
		76	American Handle Sales
28	General Electric	77	Vara Semiconductor
		78	Dialco
29	Helipot	79	Elmenco
30	Heyman Mfg	80	Amp Incorporated
31	ITHACO	81	Berg
		82	Comp Corp
32	E F Johnson	83	Hewlett-Packard
		84	Beckman Helipot
33	Litronix	85	Raytheon
		86	Intersil
34	Marco-Oak Industries	87	A H & H
35	Motorola Semiconductor Prod	88	ADC Products
		89	Scanbe
36	National Semiconductor	90	Drake
		91	Victoreen
37	Ohmite Mfg	92	Frost
		93	Sigma
38	Paktron	94	Becon
39	Panduit	95	Microswitch
40	Pomona Electronics	96	Wavetek
41	Product Components	97	Electronic Concepts
42	Pyrofilm	98	Amelco
		99	Mepco
43	RCL Electronics	100	RCA
44	Rembrandt	101	Circuit Asm Corp
45	Rogan	102	Monsanto
		103	Ainsley
46	Schauer Mfg	104	Keystone Carbon
47	H H Smith	105	JFD
48	Sprague Electric	106	EAC
49	Spectrol Electronics	107	Douglas Randall
50	Stancor	108	Siliconix

TABLE 6.3 CODE LIST OF MANUFACTURERS



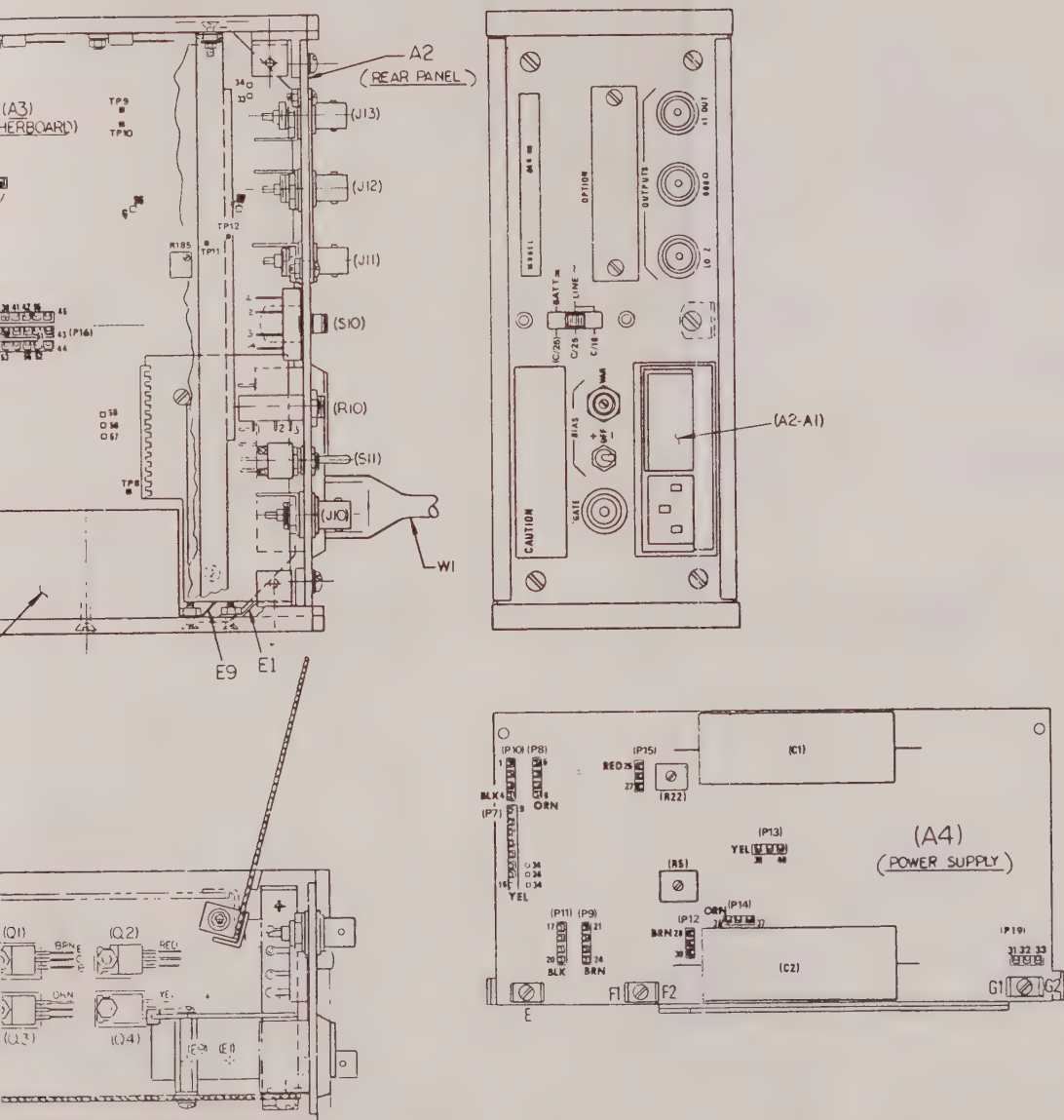
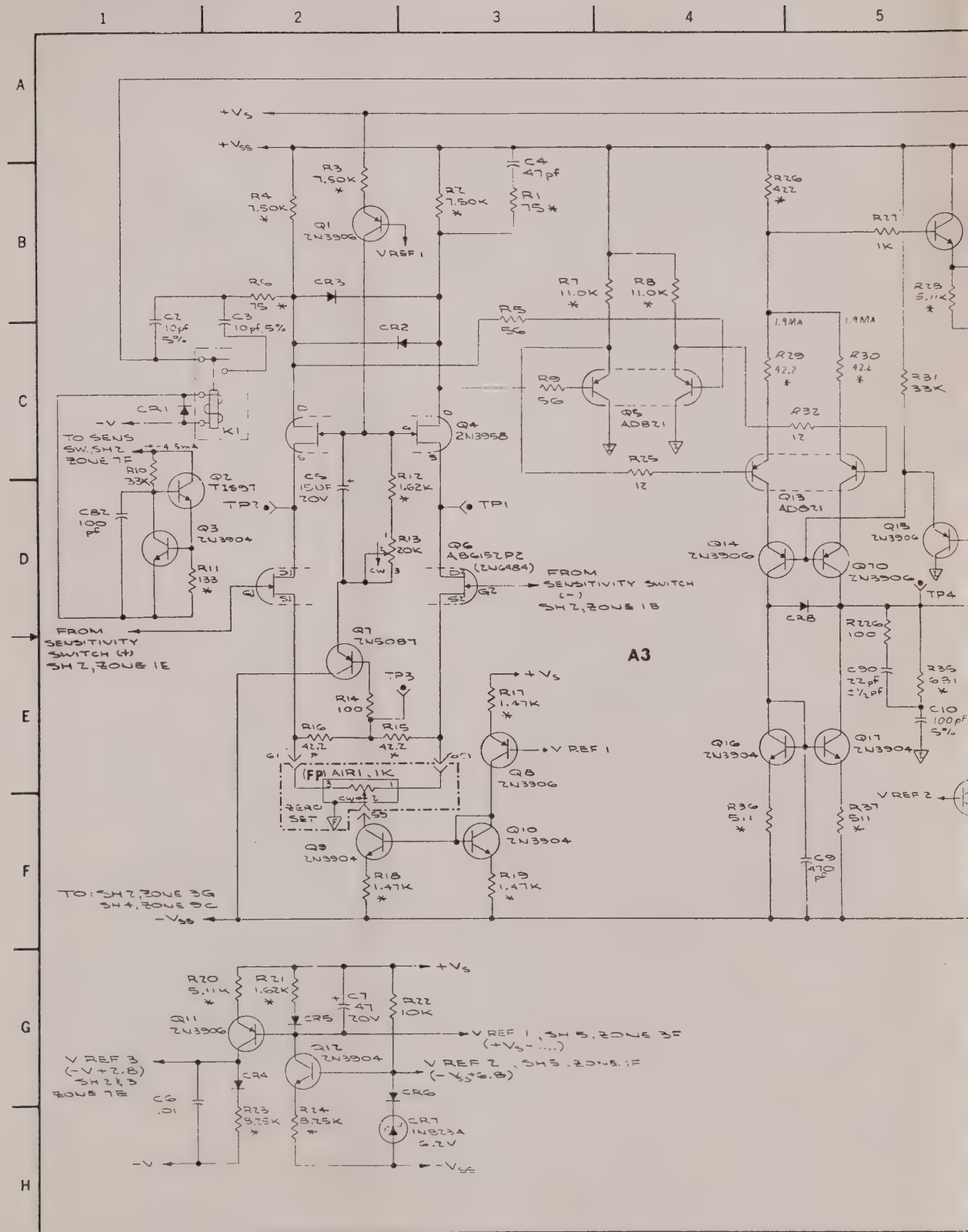


FIGURE 7.1
MAJOR ASSEMBLY
MODEL 1211



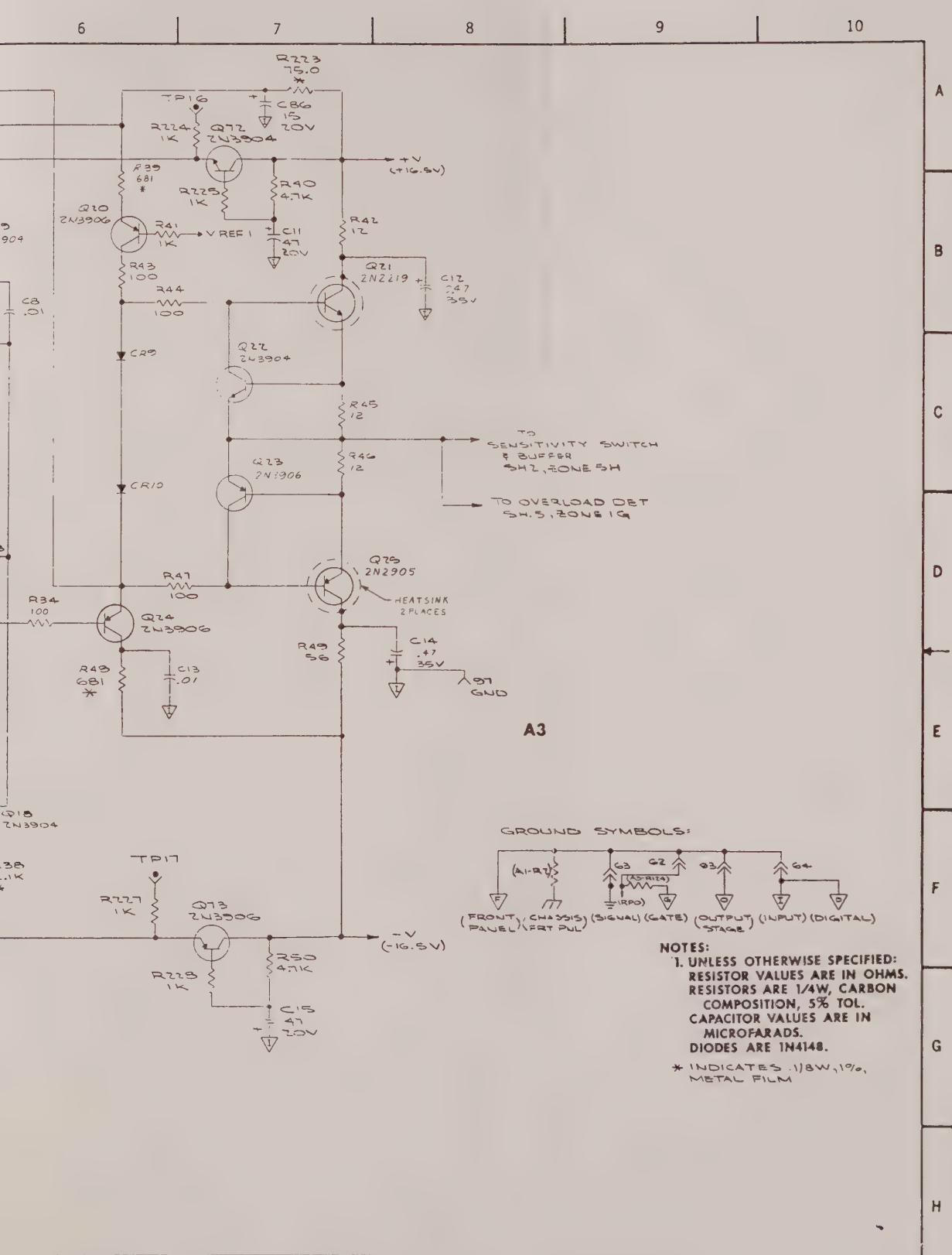
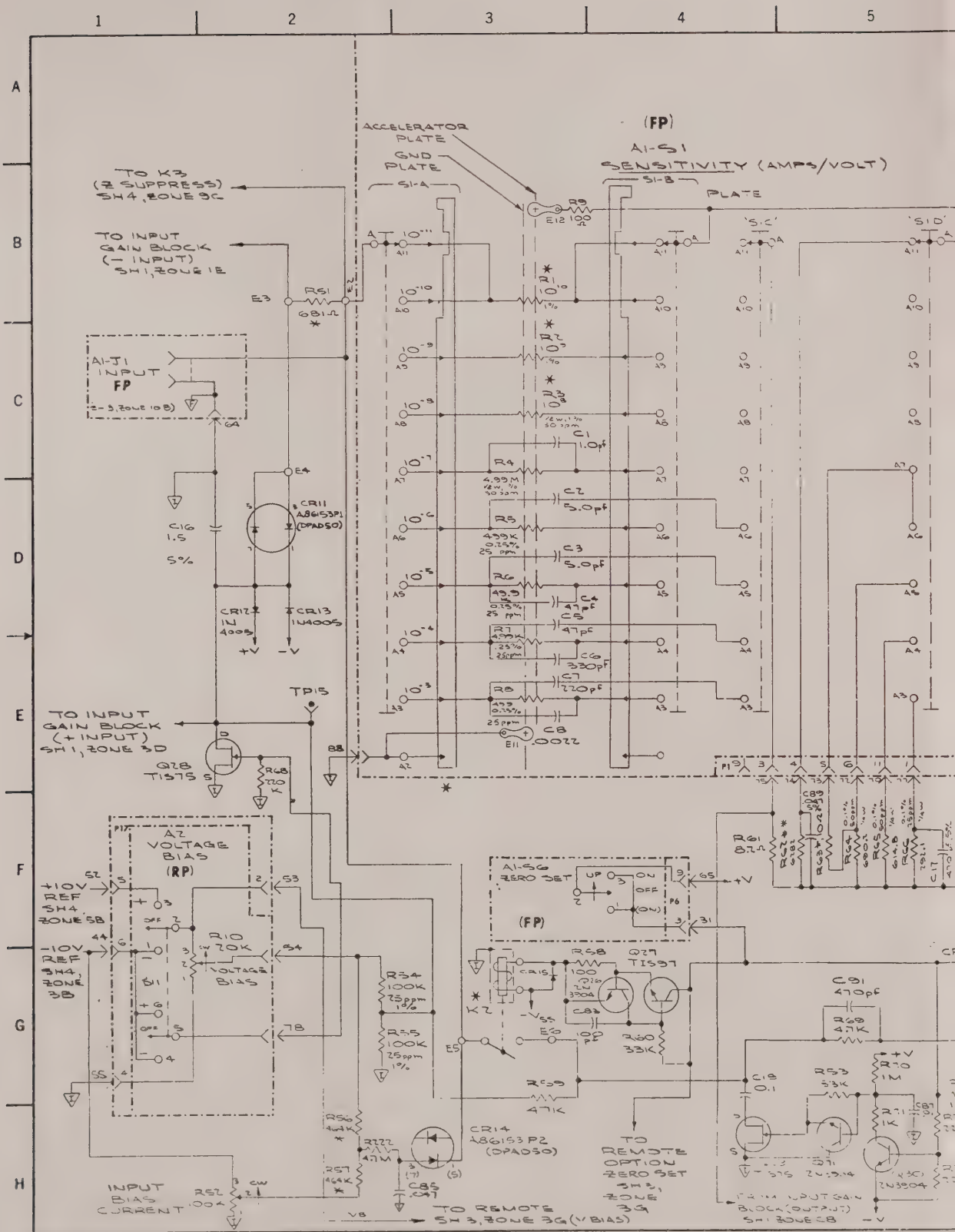
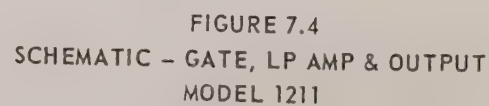
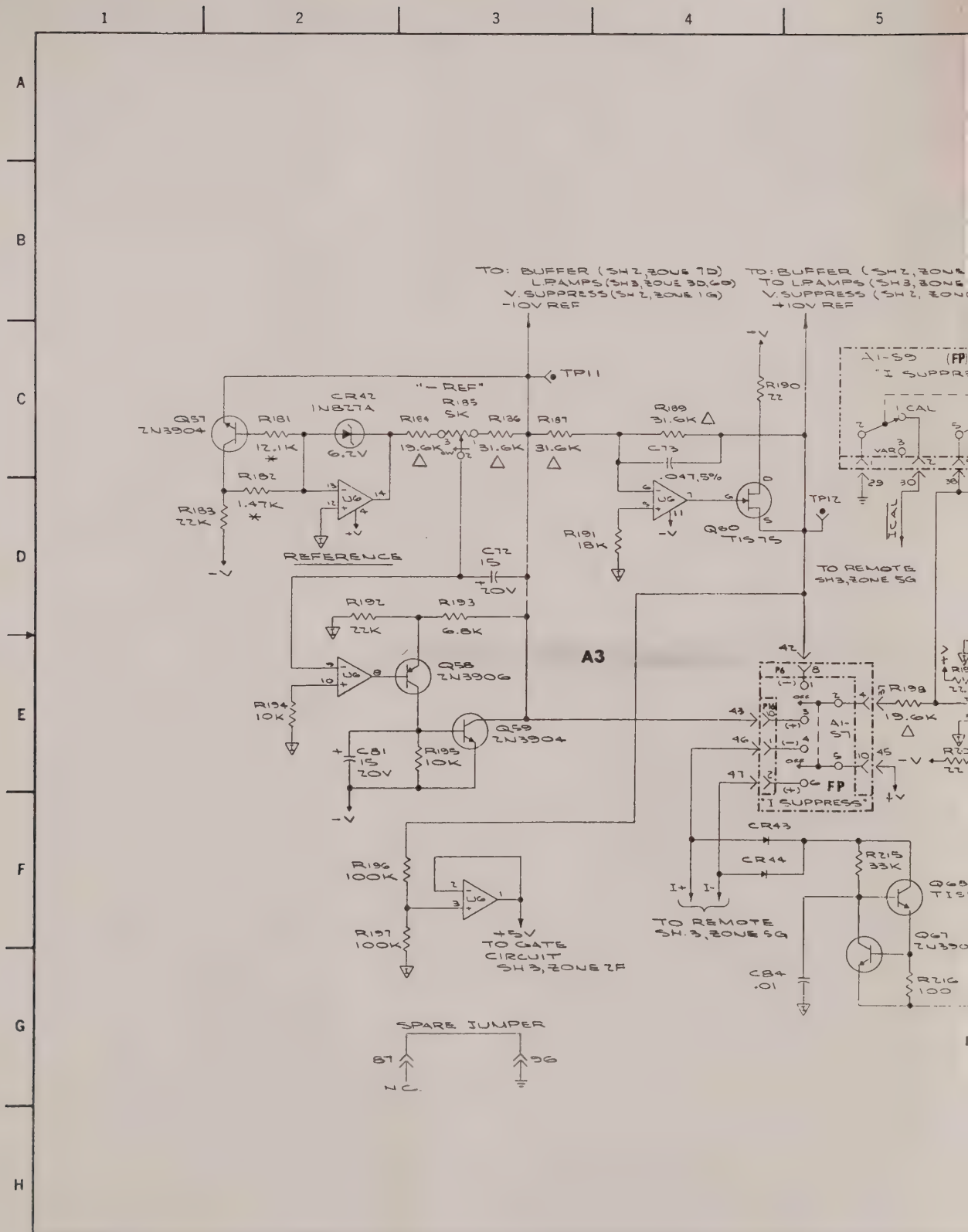


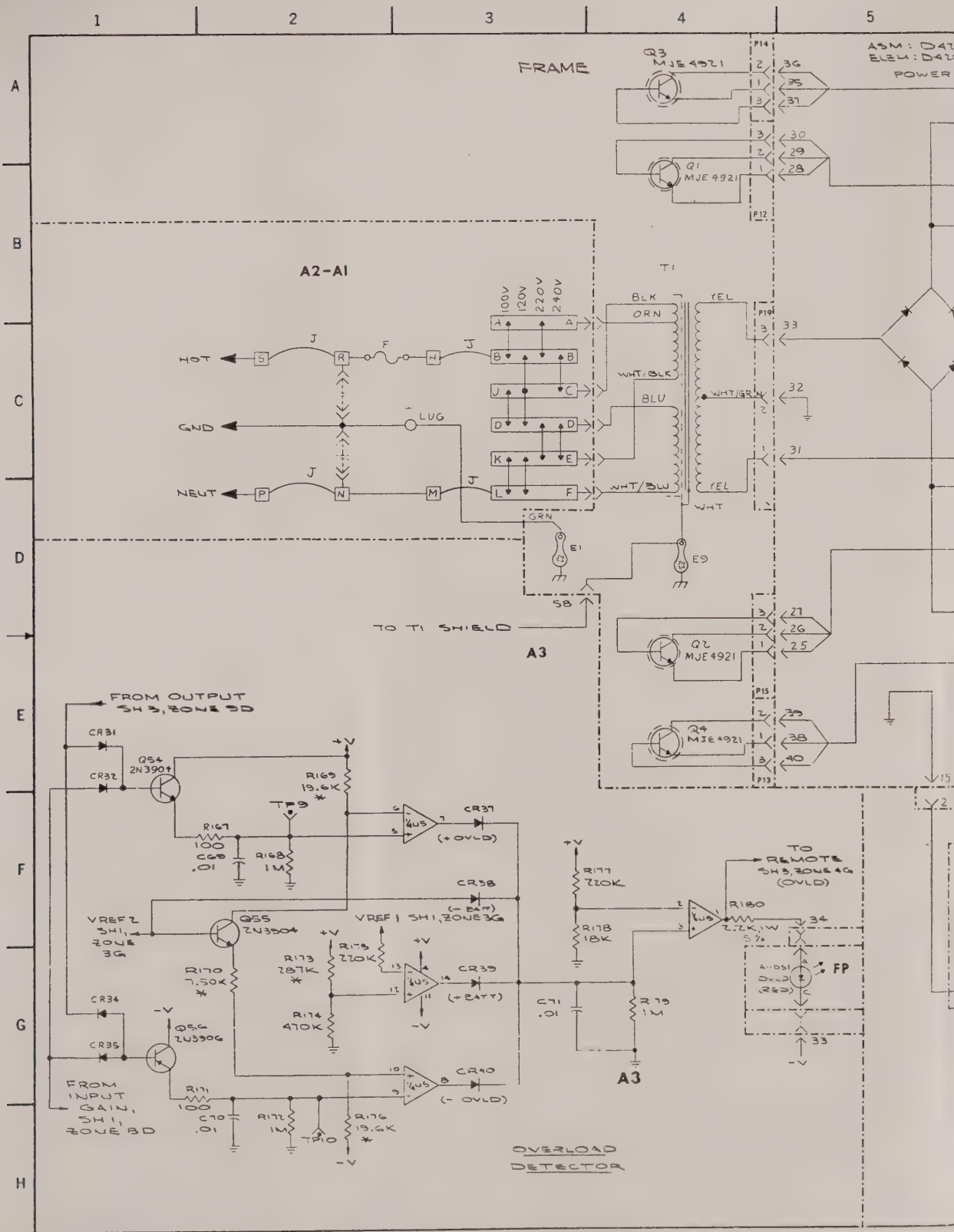
FIGURE 7.2
SCHEMATIC - INPUT GAIN
MODEL 1211











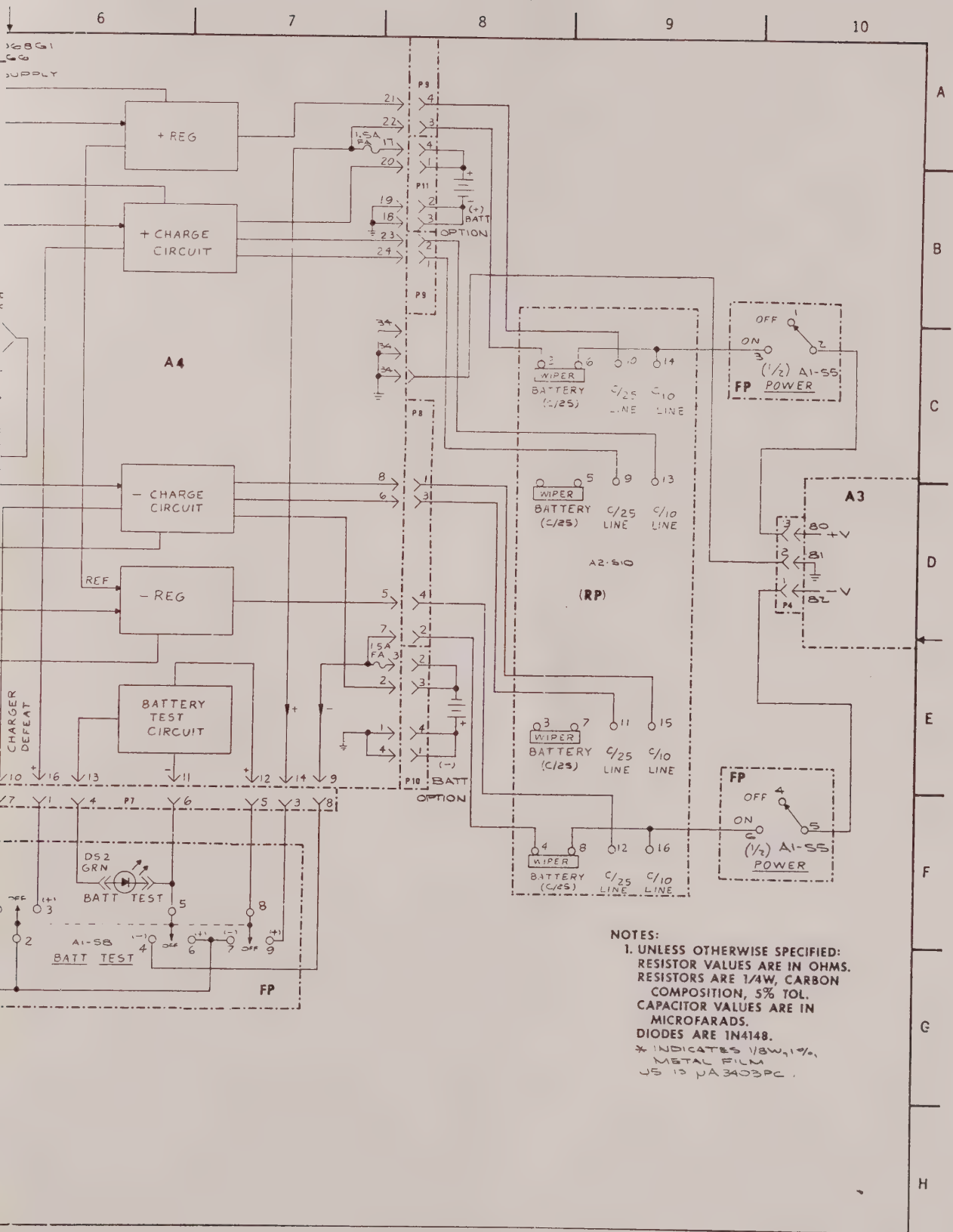


FIGURE 7.6
SCHEMATIC - POWER SUPPLY/OVLD
MODEL 1211

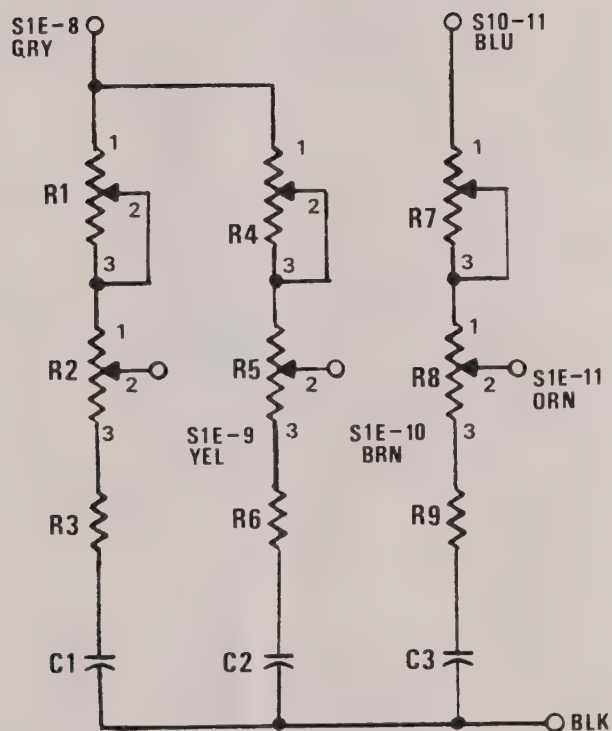


FIGURE 7.7 SCHEMATIC - A5 CARD MODEL 1211

2

3

4

5

A

B

C

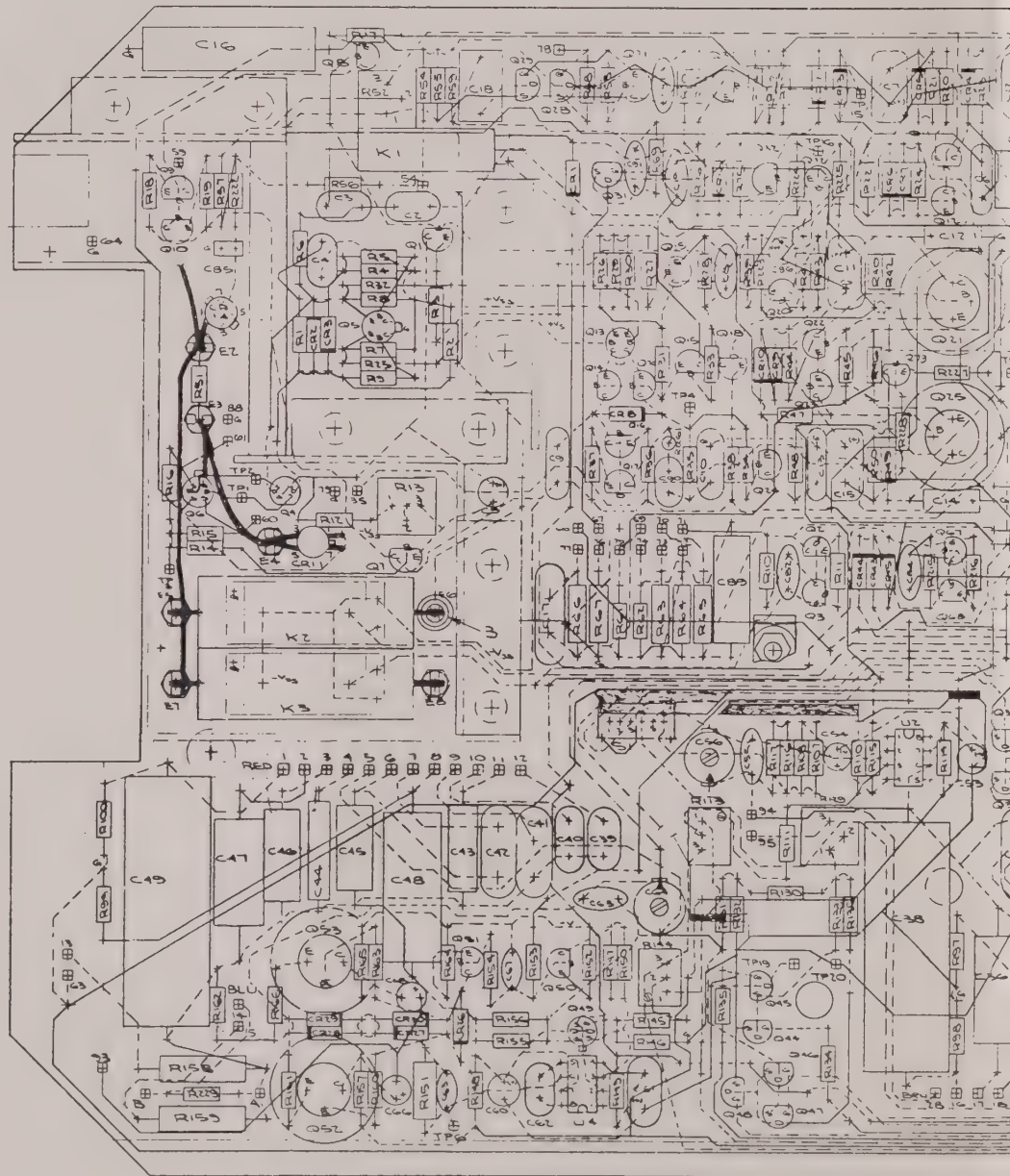
D

E

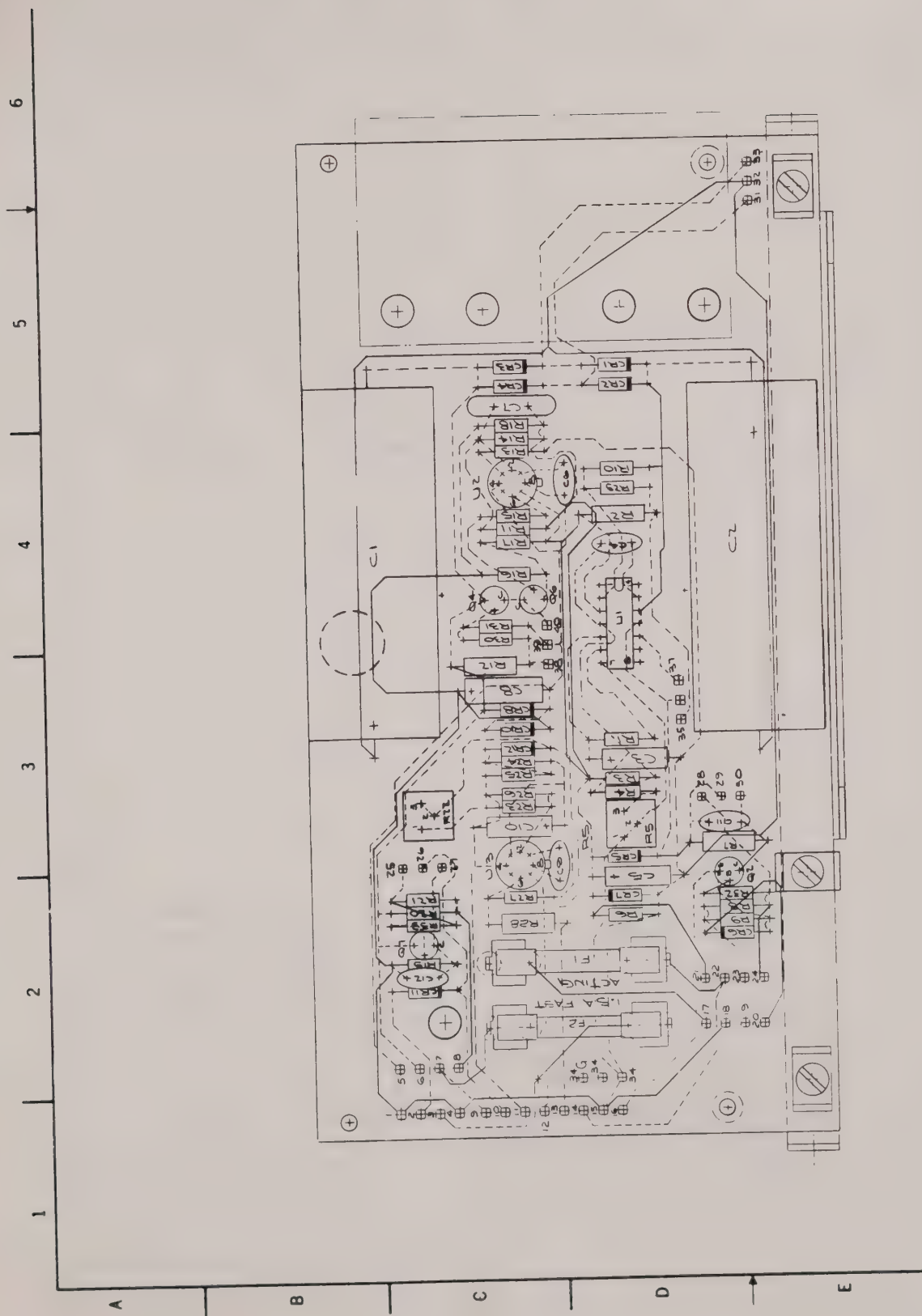
F

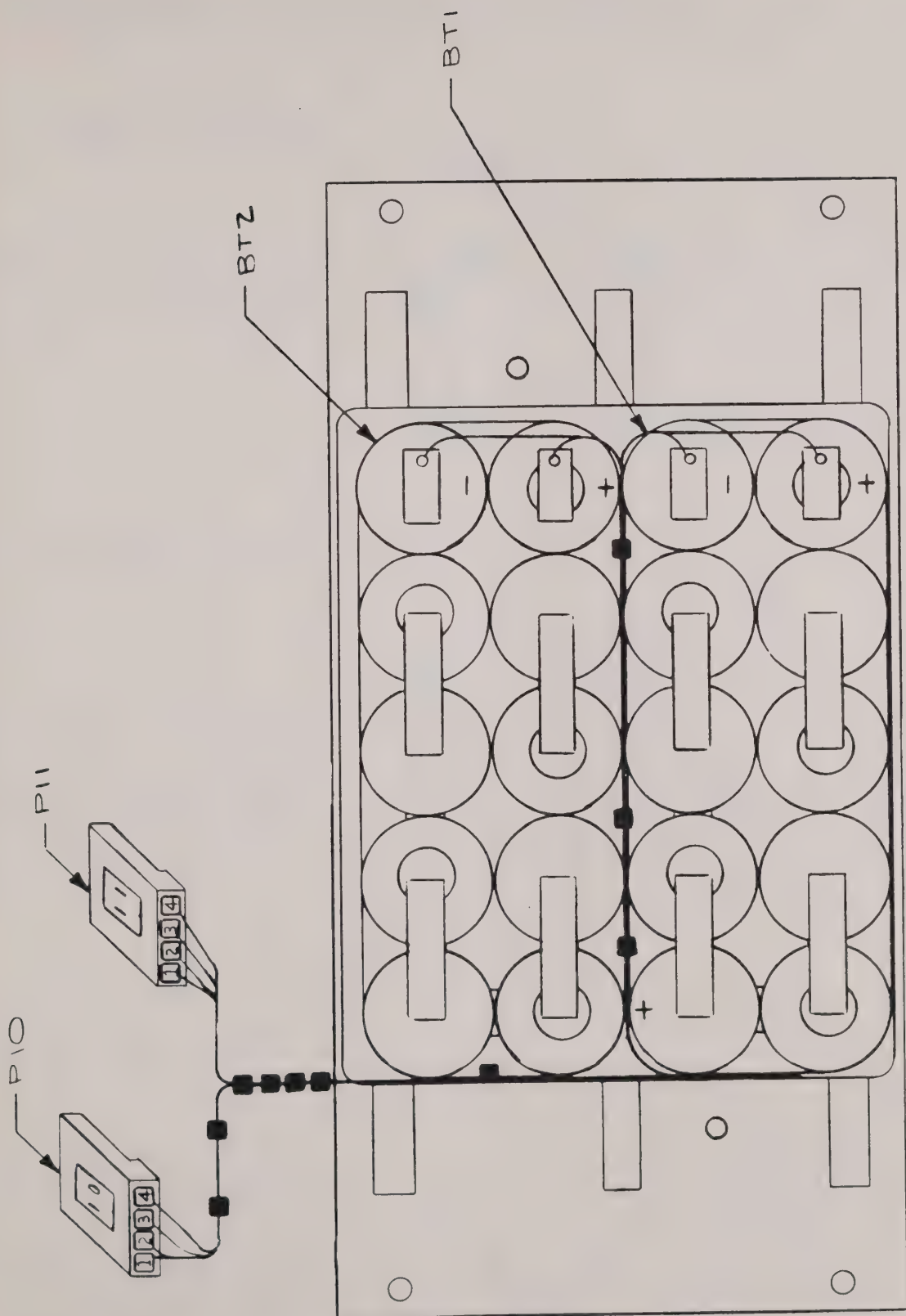
G

H



D. PECARD

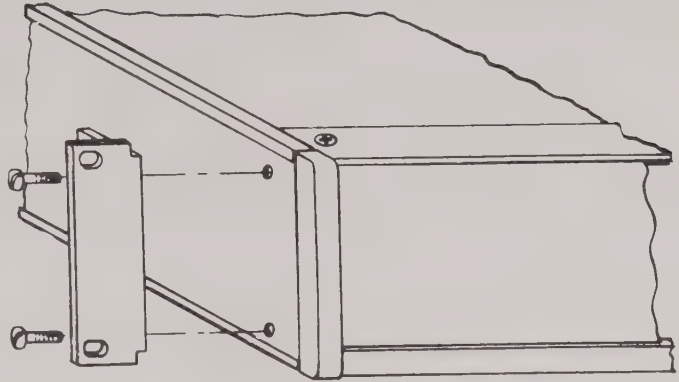




INSTALLATION INSTRUCTIONS FOR ITHACO RACK MOUNTING KITS RM-1 AND RM-2

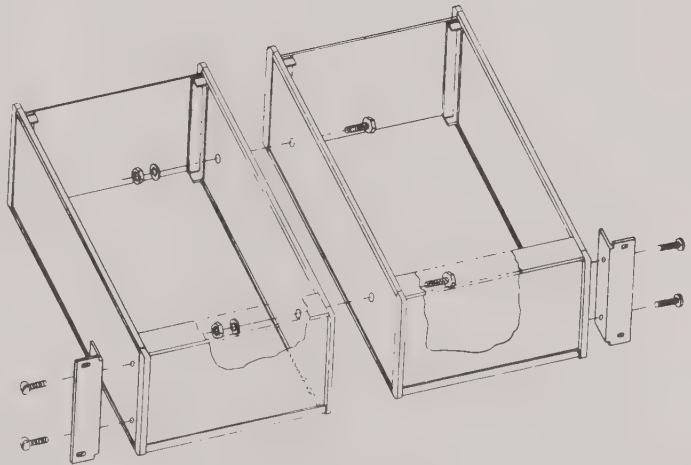
RM-1 FOR 17" WIDE FULL RACK CHASSIS:

Remove the two screws at the front of each side cover. Place mounting ears of the RM-1 kit in place and secure using the screws previously removed.



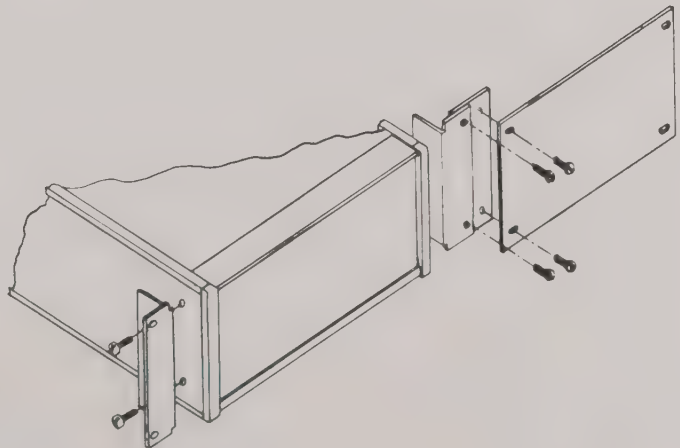
RM-1 FOR TWO 8½" WIDE HALF RACK CHASSIS:

Remove opposite side covers from each unit. Remove top covers from each unit, secure the units together side by side, using nuts and bolts supplied. Replace the top covers, attach mounting ears in the same manner as a full rack unit.



RM-2 FOR A 8½" WIDE HALF RACK UNIT

Remove the two screws at the front of each side cover. Place mounting ears in place and secure, using the screws previously removed. Attach extender plate to mounting ear on the desired side of the unit, secure using the threaded nut bar and hardware supplied.



**RECOMMENDED HANDLING PROCEDURES
FOR
STATIC SENSITIVE DEVICES**

ITHACO



735 W. Clinton St. Box 6437 Ithaca, New York 14850-6437 Phone 607-272-7640 TWX 510-255-9307

GENERAL

Static Sensitive Devices (Insulated Gate), due to their extremely high input resistance, are subject to potential damage by the accumulation of excess static charge. To avoid possible damage to the devices during handling, testing, or actual operation, these procedures should be followed:

NOTE: Dry weather (relative humidity less than 30%) tends to multiply the accumulation of static charges on any surface. In a low humidity environment, the handling precautions take on added importance and should be adhered to without exceptions.

Various electrical and electronic parts which have been determined to be sensitive to electrostatic discharge include: microelectronic and semiconductor devices, thick and thin film resistors, chips and hybrid devices, and piezoelectric crystals. Additionally, all subassemblies, assemblies and equipment containing these parts not having adequate protective circuitry are also electrostatic discharge sensitive (ESDS).

PROCEDURE

- A. The leads of the devices should be in contact with a conductive material except when being tested or in actual operation, to avoid the build-up of static charge.
 1. The conductive material may be a conductive foam, metal foil, conductive rings or other suitable material.
- B. Devices should not be inserted in non-conductive containers such as conventional styrofoam, plastic bubble paper, or trays.
- C. When devices are removed from their conductive material, the hand being used should be grounded by a metal wrist strap which has a 1 megohm resistor in series with the wire between the strap and ground.
- D. All soldering iron tips, test equipment, tools and fixtures must be grounded. Table tops and work surfaces should be conductive and grounded.
- E. All grounds must be common and should be made as close together as possible.
- F. Devices should not be inserted into or removed from circuits with the power on.
- G. Signals should not be applied to the inputs while the device power supply is off.

WARRANTY

ITHACO Inc. warrants each instrument to be free of defects in material and workmanship for a period of one year after shipment to the original purchaser; batteries are specifically excluded. Liability under this warranty is limited to repairing or adjusting any instrument returned to the factory for that purpose. The warranty of this instrument is void if the instrument has been modified other than in accordance with written instructions from ITHACO, or if defect or failure is judged by ITHACO to be caused by abnormal conditions of operation, storage or transportation.

This warranty is subject to verification by ITHACO, that a defect or failure exists, and to compliance by the original purchaser with the following instructions:

1. Before returning the instrument, notify ITHACO with full details of the problem; include model number and serial number of the instrument involved.
2. After receiving the above information, ITHACO will give you shipping instructions or service instructions. After receipt of shipping instructions, ship the instrument to ITHACO. Full liability for damage during shipment is borne by the purchaser. It is recommended that instruments shipped to us be fully insured and packed surrounded by at least 2 inches of shock-absorbing material.

ITHACO reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of ITHACO, and ITHACO neither assumes, nor authorizes any other person to assume for it, any liability in connection with the sales of ITHACO instruments.

ITHACO INC.
735 W. Clinton Street
Ithaca, New York 14850
Telephone: 607-272-7640



MP MASTER



MA34221